Iron and Steel ENGINEER

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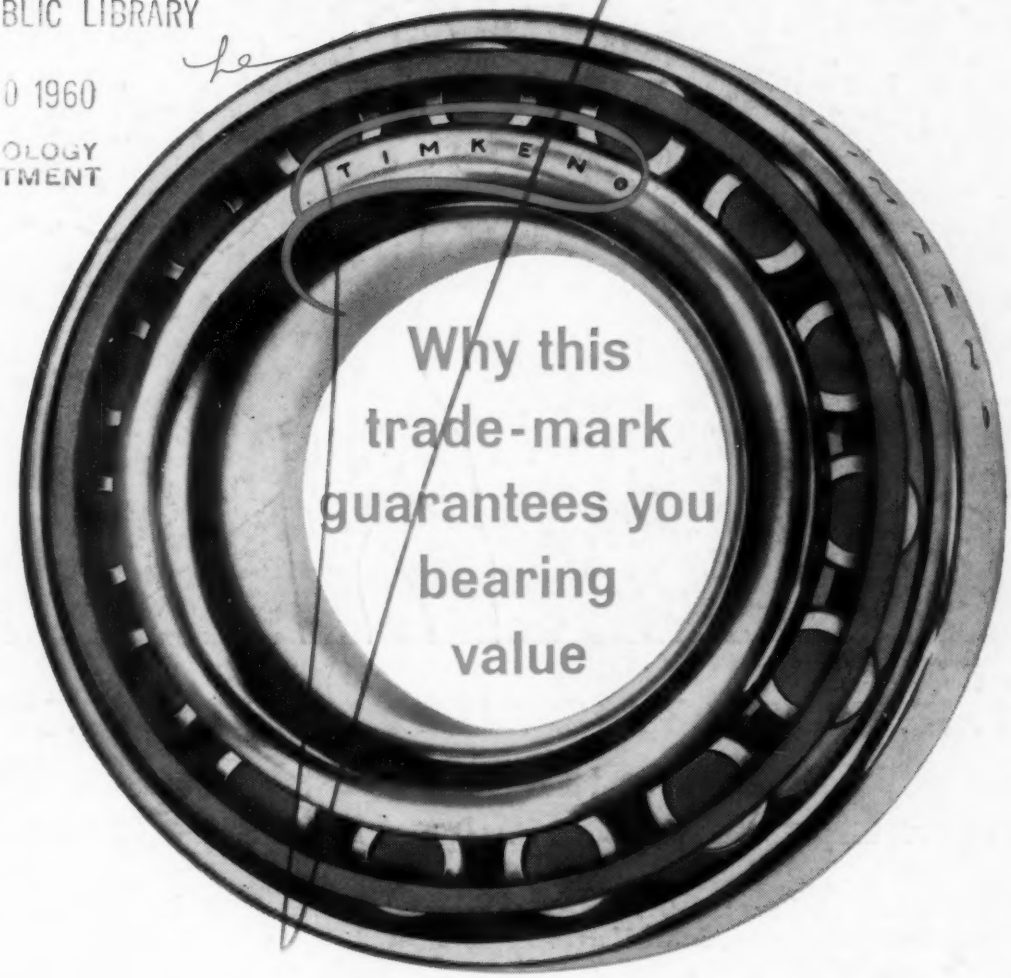

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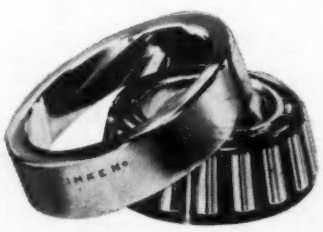

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World's largest Cupolas are equipped with Cutler-Hammer Control

To satisfy the 50 tons per hour appetite of Acme Steel's new giant hot blast cupolas, Cutler-Hammer engineered the fully automatic charging control system. Another industry "first", this amazing system directs the synchronized operations of the twin charging buckets between the stock area and cupola top from a single control station. With push-button control the scrap iron, coke, and stone are weighed, logged, and dumped into a waiting charging bucket. The bucket is automatically transferred to the special hooded charging crane which carries the load to the cupola top. Here the motions of the charging crane are integrated with those of the cupola's pressure cap and gates to permit discharging of the bucket onto the burden without losing top pressure.

The development of this *new* and *different* charging system and its control is another typical example of mill engineers, equipment manufacturers, and Cutler-Hammer engineers working together to solve *new* and *different* mill problems. Remember this when you are planning new facilities or modernizing existing machines and processes. Cutler-Hammer's 68 years of Mill Control experience can prove to be a valuable asset to you during the early planning stages. Your inquiry will receive prompt attention without obligation. Dept. A-232, Cutler-Hammer Inc., Milwaukee 1, Wisconsin.

Look to Cutler-Hammer Mill Experience . . . as broad as it is long

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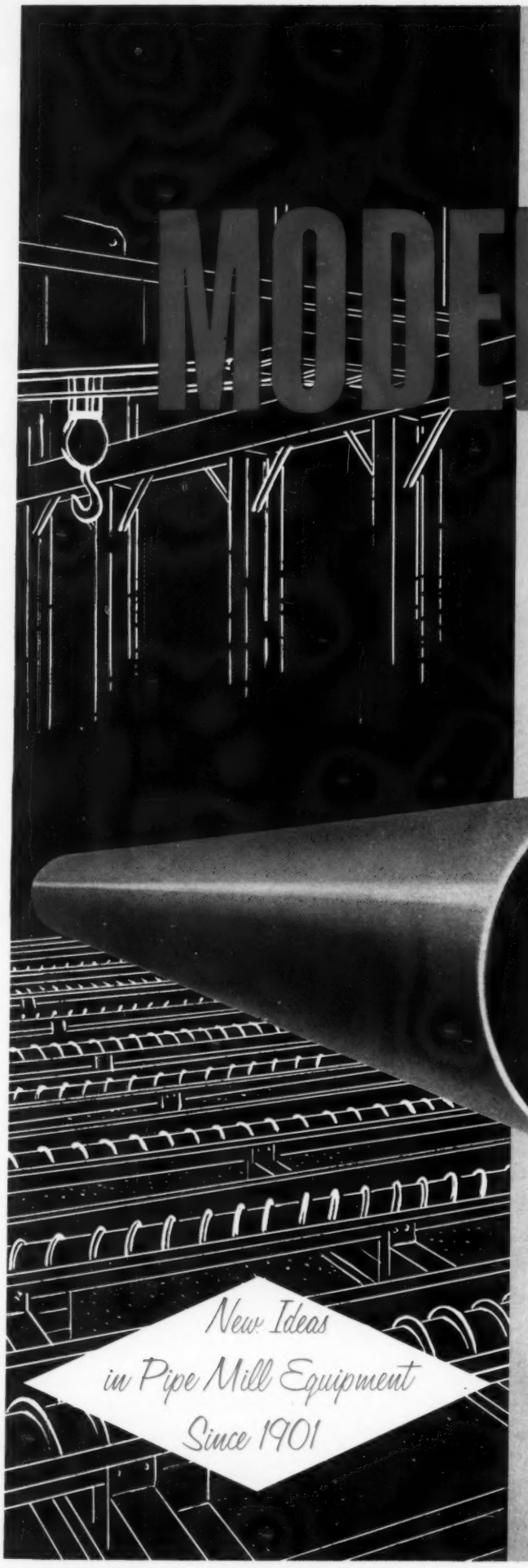

Pipe mills, too, need MODERNIZING

We are doing a lot of work these days on modernizing Continuous Butt Weld Pipe Mills and Seamless Tube Mills.

The continued and projected demand for pipe and tubes makes modernization of mills a must to maintain a competitive position in the business.

Individual items of the mills can be revamped. Existing mills can be rebuilt. Mills can be moved from one location to another.

As the "pipe mill people", we are constantly developing new ideas for new mills and existing mills. These ideas center on two main points: (1) to increase production and (2) to improve the quality of the pipe or tube.

We would like to talk to you about these new ideas and show you how your mills can be made more profitable. Write to Aetna-Standard Division, Blaw-Knox Company, Pittsburgh 30, Pennsylvania.

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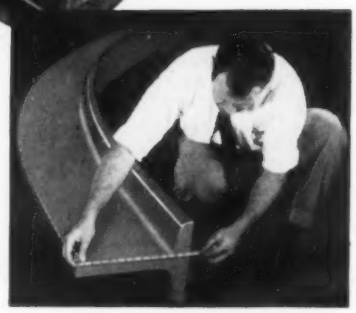
WORLD'S LARGEST STRUCTURAL BENDER USES LARGEST AIR TUBE CLUTCH

Mammouth McKay bender curves 14" steel tee beams easily with help of giant Wichita Air Tube Clutch

Tremendous torque is applied through a 48" Wichita Air Tube Disc Clutch at 0.75 rpm from the 60 hp, 1650 rpm drive motor to the center driving roll. McKay engineers report Wichita ATD clutch provides smooth power application in spite of heavy loads. For your unusual or difficult clutching or braking problems it will pay you to call in a Wichita engineer.



Structural tee shape bent stem out – 10" flange, 14" stem.

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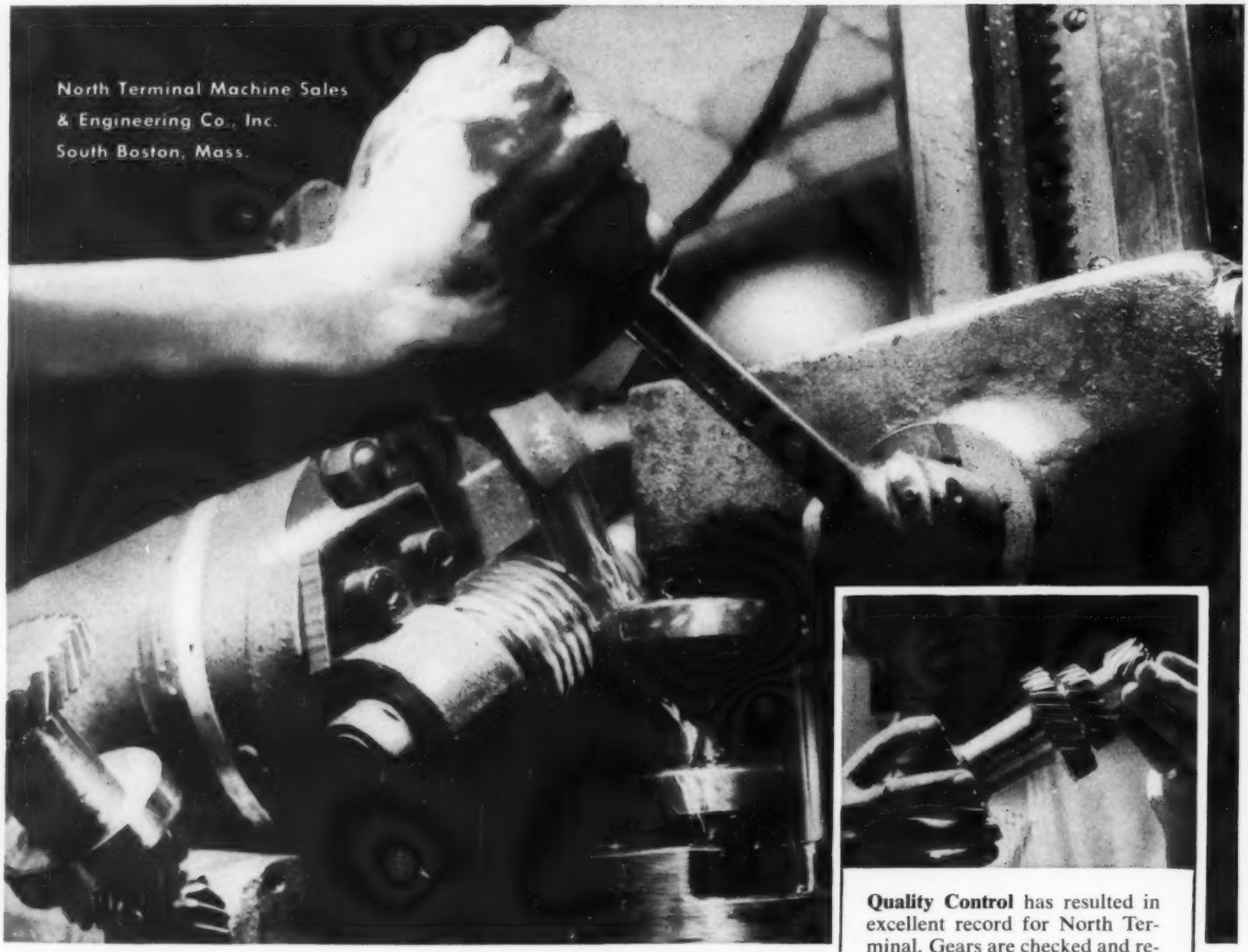


Quality Control has resulted in excellent record for North Terminal. Gears are checked and rechecked after each step in production. Quality lubricants have helped hold to close tolerances.

Hob Life Increased 250% with Cities Service Chillo 10 Cutting Oil

North Terminal makes replacement gears for automobile transmissions. In a day's time the firm—which makes the gears from raw stock to finished product—completes up to 5600 gears. Producing in quantities like this, hob life is an important consideration in *cost* of production as well as *quality* of production.

Previous cutting oils were tested on the gear hobbing machines and they resulted in hobs producing as low as 87 gears before replacement. Cities Service Chillo 10 cutting oil under the same conditions resulted in over 200 gears with a superior finish before a hob replacement was necessary.

5600 Gears per day or the equivalent of 800 replaced transmissions are produced every day by North Terminal. Gears are made for all makes of cars with a good portion of production being shipped overseas.

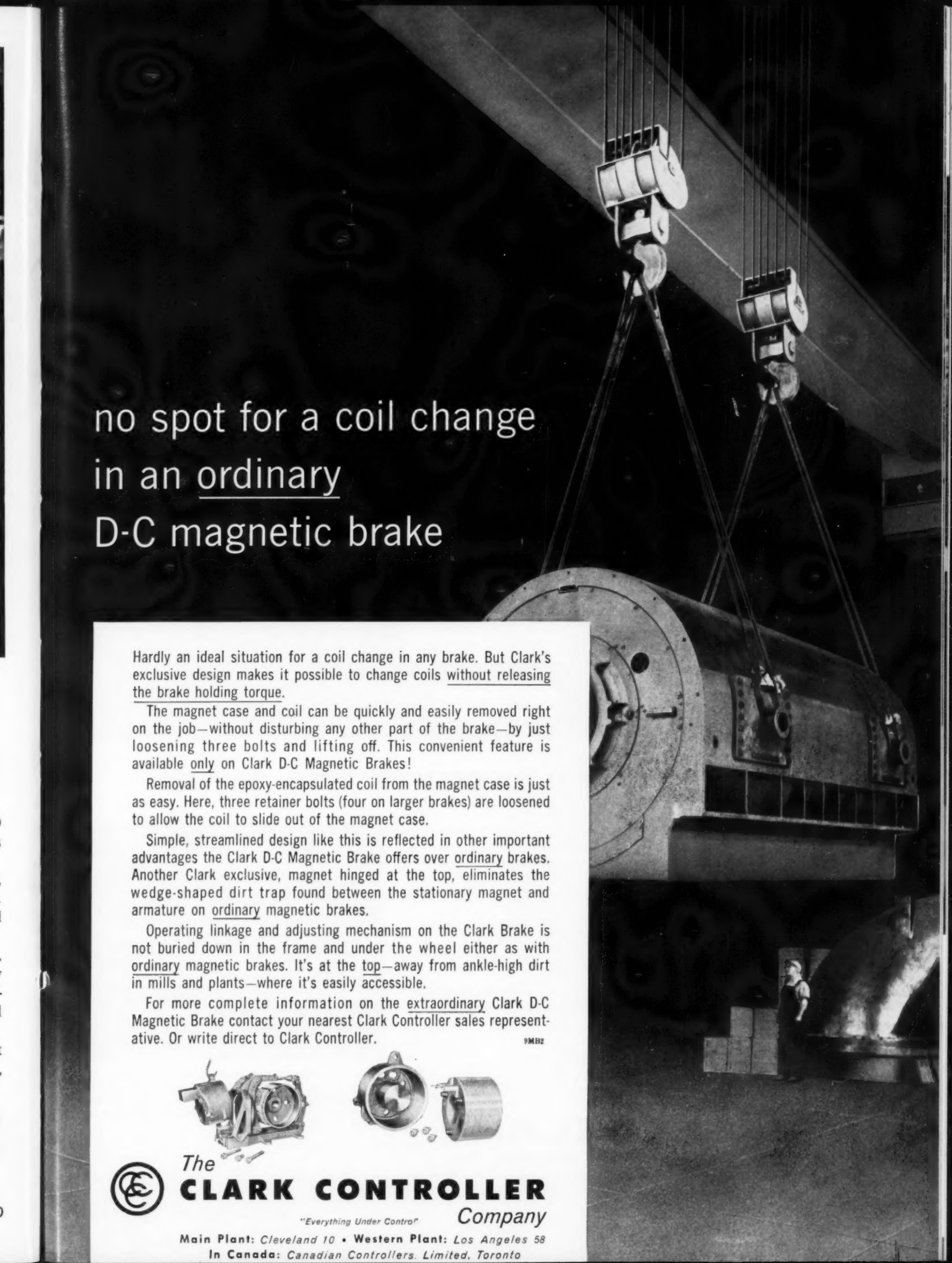
Edward W. Malley Jr., President of North Terminal, states, "We didn't choose Cities Service cutting oil blindly. Many competitive oils were tested before we were satisfied that Chillo 10 was superior in every way."

Even if you're satisfied with your present cutting oil, a test of Cities Service Chillo 10 may give you a very pleasant surprise. Test after test under actual manufacturing conditions has shown Chillo 10 to give longer tool life and superior finishes.

Arrange for your own test by calling your nearest Cities Service office or write: Cities Service Oil Company, Sixty Wall Tower, New York 5, New York.

CITIES SERVICE

QUALITY PETROLEUM PRODUCTS



no spot for a coil change in an ordinary D-C magnetic brake

Hardly an ideal situation for a coil change in any brake. But Clark's exclusive design makes it possible to change coils without releasing the brake holding torque.

The magnet case and coil can be quickly and easily removed right on the job—without disturbing any other part of the brake—by just loosening three bolts and lifting off. This convenient feature is available only on Clark D-C Magnetic Brakes!

Removal of the epoxy-encapsulated coil from the magnet case is just as easy. Here, three retainer bolts (four on larger brakes) are loosened to allow the coil to slide out of the magnet case.

Simple, streamlined design like this is reflected in other important advantages the Clark D-C Magnetic Brake offers over ordinary brakes. Another Clark exclusive, magnet hinged at the top, eliminates the wedge-shaped dirt trap found between the stationary magnet and armature on ordinary magnetic brakes.

Operating linkage and adjusting mechanism on the Clark Brake is not buried down in the frame and under the wheel either as with ordinary magnetic brakes. It's at the top—away from ankle-high dirt in mills and plants—where it's easily accessible.

For more complete information on the extraordinary Clark D-C Magnetic Brake contact your nearest Clark Controller sales representative. Or write direct to Clark Controller. 9MB2

The **CLARK CONTROLLER** Company

"Everything Under Control"

Main Plant: *Cleveland 10* • **Western Plant:** *Los Angeles 58*
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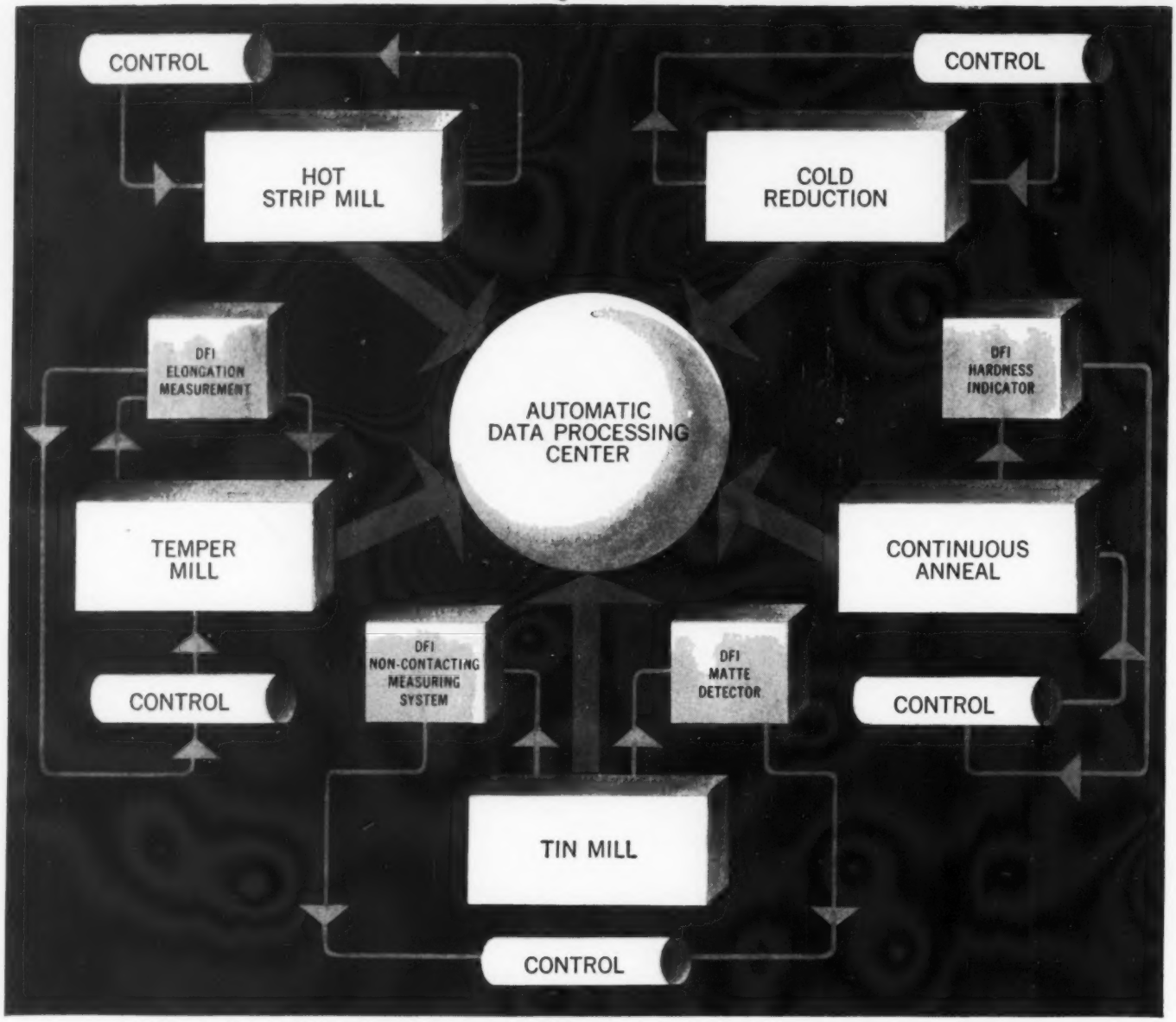


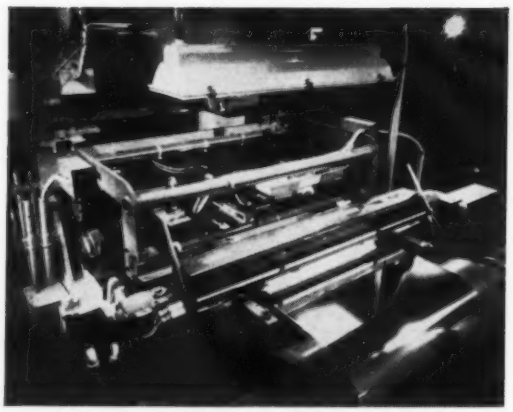
NEW SYSTEM CONCEPTS FOR STEEL

Need sensors and process control *unlike anything available yesterday?*

Using new design concepts, DfI-Cleveland offers optimum solutions to some of the more pressing problems, such as: non-contacting lineal measurement, elongation measurement, weld detection, matte detection, hardness indication. Our complete service includes design, development and fabrication.

As an example of *research* capabilities, DfI has recently completed major systems studies for several large steel producers which included: (A) economic and technical evaluations; (B) positive recommendations; (C) systems fabrication.

For personal attention, write or telephone collect, Mr. William C. George, Manager—Department of Instrumentation and Process Control.



DfI Non-Contacting Lineal Measuring System in operation at Western Pennsylvania tin plate mill. This particular unit "senses" footage with an accuracy of .1% over a dynamic speed range of 300 fpm to 2400 fpm.

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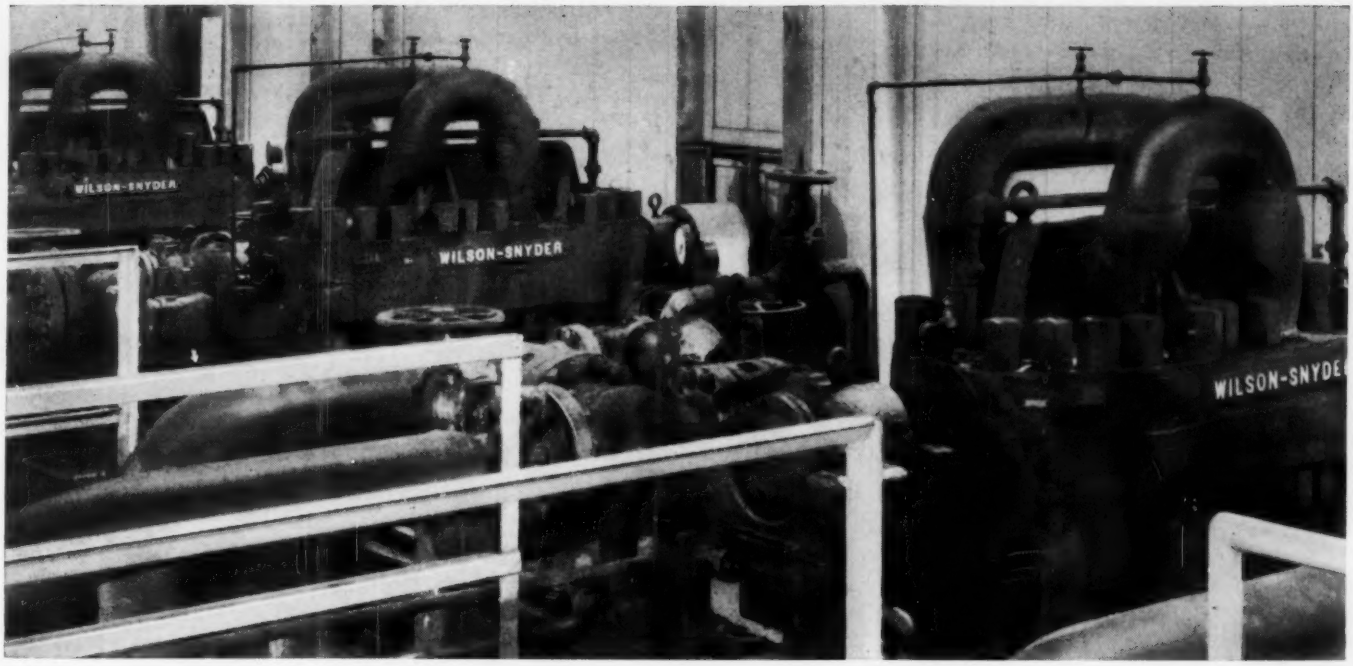

Select Wilson-Snyder pumps for your high-pressure descaling and hydraulic applications

The universal acceptance of Wilson-Snyder centrifugal pumps for the severe and exacting service which steel mill duty demands is proven by the installation and satisfactory performance of over 100,000 horsepower in the United States and seven foreign countries. Pumps of this type are available for capacities to 1,500 gpm and discharge pressures to 1,800 psi at speeds from 1,800 to 4,100 rpm, depending upon water conditions. The complete size range includes capacities up to 35,000 gpm.

For lower capacities and higher pressures, our extensive line of reciprocating pumps includes triplex and quintuplex single-acting plunger types as well as duplex double-acting plunger type for either descaling or general hydraulic system applications. From this line, you can develop pressures up to 10,000 psi.

In addition to pumps, Wilson-Snyder can engineer and furnish complete equipment for your descaling system—including headers, nozzles, spray valves, accumulators, charging compressors, strainers and other components.

WRITE FOR CATALOG containing complete pump specifications and let us quote on your requirements. Wilson-Snyder Works, Oil Well Supply Division of United States Steel, Braddock, Pennsylvania.

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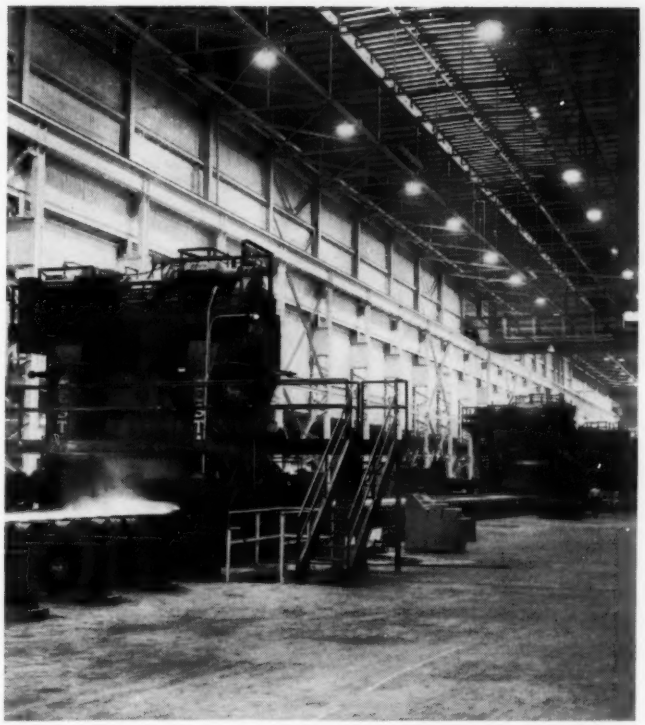


Kaiser Steel's new hot strip mill is housed in a building more than a half mile long. The building covers eight acres. In just two minutes a steel slab travels from the furnaces at one end of the building, through the 11 rolling mills to the coiler at the far end. This is a distance of 1,245 feet. A typical slab—40 inches wide, 4 inches thick, and 22 feet long—completes the journey as a coiled sheet about a quarter of a mile long. Effective descaling at this new mill is performed by 3 Wilson-Snyder 6-Stage, 3,600-rpm centrifugal pumps shown in the main illustration, each driven by a 1,500-hp motor.

SIEMENS

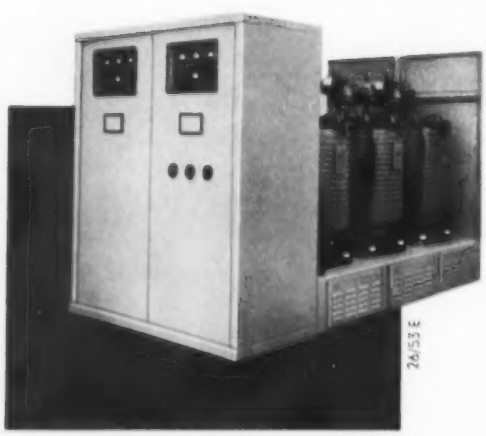
The world's first excitron-controlled tandem cold-strip rolling mill (August Thyssen Steelworks)

Having considered all the pros and cons...

. . . you will agree that static-convertor-controlled drives are superior.

They are proving their worth from day to day.

Siemens static convertors are pumpless, grid-controlled steel-tank units of the excitron type. They can be controlled steplessly between the maximum positive and negative voltage limits, no matter whether the drive operates as a motor or as a generator. Thanks to the unitized system of construction plants can be assembled for any desired output.



Excitron convertor set with 6 single-anode tanks for d.c. voltages up to approx. 1,600 V and continous currents up to approx. 3,500 A (r.m.s.), maximum currents up to approx. 9,000 A (r.m.s.). Weight of a mercury-arc unit approx. 440 lb (200 kg) Weight of a complete convertor set approx. 6,600 lb (3,000 kg). Area of base 6 ft × 11 ft (1.8 × 3.3 m)

Here are some of the main advantages of the Siemens excitron convertors:

They require a minimum of floor space. Being light in weight, they need no expensive foundations and cranes.

They have no moving parts - consequently there is no bearing, brush or commutator maintenance. Only a minimum of spare parts need be kept in store.

Especially in conjunction with the recently developed transistorized control and regulating equipment the Siemens static convertors provide good, i.e. rapid and precise, control.

Any place, any time: Our experts are constantly at your disposal for advice on the planning and construction of rolling-mill drives.

SIEMENS-SCHUCKERTWERKE AKTIENGESELLSCHAFT
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OHIO

Crops and Shorts

Δ Financial figures reported by the steel companies show a mixed trend. The three largest (U. S. Steel, Bethlehem and Republic) had net revenues 15 or 16 per cent under 1958. Inland showed a slight increase. Jones & Laughlin increased 26 per cent, Youngstown Sheet & Tube jumped 44 per cent. Armco and National, both with partial operations during the strike, went up 33 per cent and 53 per cent, respectively. Granite City, Copperweld, C. F. & I., Alan Wood and Crucible had healthy increases. (See table on page 147).

Δ Steel production in the United States for January, 1960, totaled 12,043,000 net tons of ingots. This is a new record and the first month to exceed 12,000,000. Operating rate was 95.4 per cent of the present capacity. The month also saw many new production records set by many departments and plants of various companies.

Blast furnaces in the United States also set a record in January with 7,830,097 net tons of pig iron and ferroalloys.

Δ World steel output hit a new record in 1959 at about 317,861,000 net tons, excluding China. This is considerably higher than the 289,244,000 tons of 1958, but only 2,000,000 above the 1957 figure. The production by countries:

United States	93,446,000
Canada	5,914,000
West Germany	32,448,000
France	16,746,000
Benelux countries	12,963,000
Italy	7,444,000
United Kingdom	22,600,000
U.S.S.R.	66,000,000
Japan	18,300,000
Other Countries	42,000,000

Δ Shipments of finished steel products from steel plants during 1959 totaled 69,377,067 net tons, according to the American Iron and Steel Institute. Of this, 18.4 per cent was in cold rolled sheets, 11.3 per cent hot rolled sheets, 10 per cent in hot rolled bars and light shapes, 8.4 per cent in plates, 7.0 per cent in electrolytic tin plate and 5.9 per cent in heavy structural shapes.

The automotive industry, as usual, was the big customer with 20.9 per cent.

Δ A cloud remains on the horizon in the form of record imports of foreign steel mill products, which totaled almost 4,400,000 tons, about 150 per cent more than 1958 imports.

Results of the St. Lawrence Seaway can be seen in the 695,000 tons of steel imports to Great Lakes ports during the first 11 months of 1959 as against 119,000 tons in the corresponding months of 1958.

Δ These are wonderful times. Most people are making more money than they earn and spending more than they make.

Δ When you squeeze tooth paste from that collapsible tube tonight, you might like to think it is one of the 1,150,013,808 sold in 1959, when manufacturers used 14,373,825 lb of lead, 9,891,168 lb of aluminum and 1,506,992 lb of tin.

Δ The Value Line Investment Survey sees steel production dropping off in the second half of 1960 and probably in 1961 as well. It estimates 1960 production at 129,000,000 tons and 1961 at 115,000,000.

Δ The Russian journal, "Coke and Chemistry," is now published in an English translation by the Coal Tar Research Association, Leeds, England.

Δ Total volume of business in the industrial heating equipment field for 1959 amounted to $107,230,000 as compared to $44,337,000 during 1958.

Δ A recent report of the Research and Policy Committee of the Committee for Economic Development advanced four recommendations for improving the nation's public schools:

Reorganization of small school districts into effective units of local government.

State governments should assume a larger share of the financial burden of schools.

Financial grants of about $600,000,000 annually should be made by the Federal government to support public schools where local income is below average.

Better local, state and Federal organization of citizens who appreciate the need for improved education.

This is typical of much of today's thinking. It seems that better education is being confused with physical plant. We could build the finest schools in every district and not improve education one whit. On the other hand, we could, with our present facilities, greatly improve education by overhauling our curricula. A firmer schedule of required subjects, with fewer electives, is part of the answer. Elimination of many nonessential "pipe" courses would help. Restoration of some elements of disciplined work in place of sugar-coated, spoon-fed methods would help even more.

Textbooks should be searchingly scrutinized. It's a sad commentary that a science class in one school likes the translation of a business-like Russian textbook better than the elaborate colored text they had been using.

Of course, there's another point about the CED recommendations that goes against the grain. We have always felt that local expenditures should be covered by local taxes. The farther the spending (or using) body is separated from the taxing body, the more waste and extravagance we have. Too many think "It's free. Grab some before the others take it all."

River of steel on rails

Giant molds, filled with cherry-red molten steel, roll past a nearly completed electric furnace plant en route to the stripper. United Engineers has served many of the country's leading steel producers on projects of widest scope—designing and installing such facilities as rolling mills, slab heating furnaces, sintering strands, desulfurizer stations, oxygen plants, power plants, and coal handling equipment. Each project demonstrates the time and cost-saving advantages in our coordination of design, purchasing, expediting and construction. We invite you to share and profit from our background of 75 years' experience as designers, construction engineers, and engineering consultants.

Painting by Stanley Meltzoff

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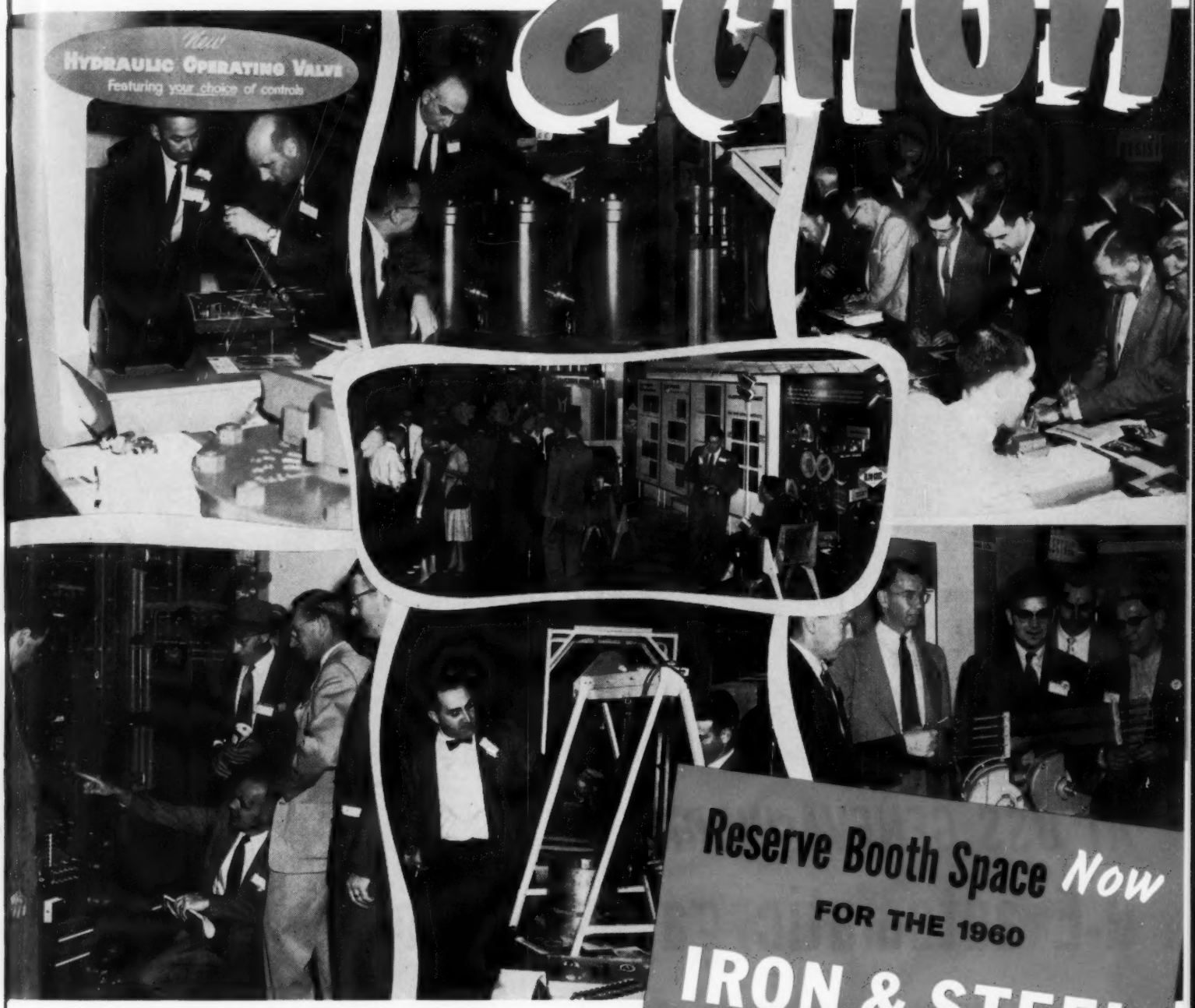

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The Iron & Steel Exposition is held every second year in conjunction with four full days of technical sessions in the same auditorium. *For Details, Costs and a Booth Floor Plan—write or phone Exposition Manager at AISE (Atlantic 1-6323).*

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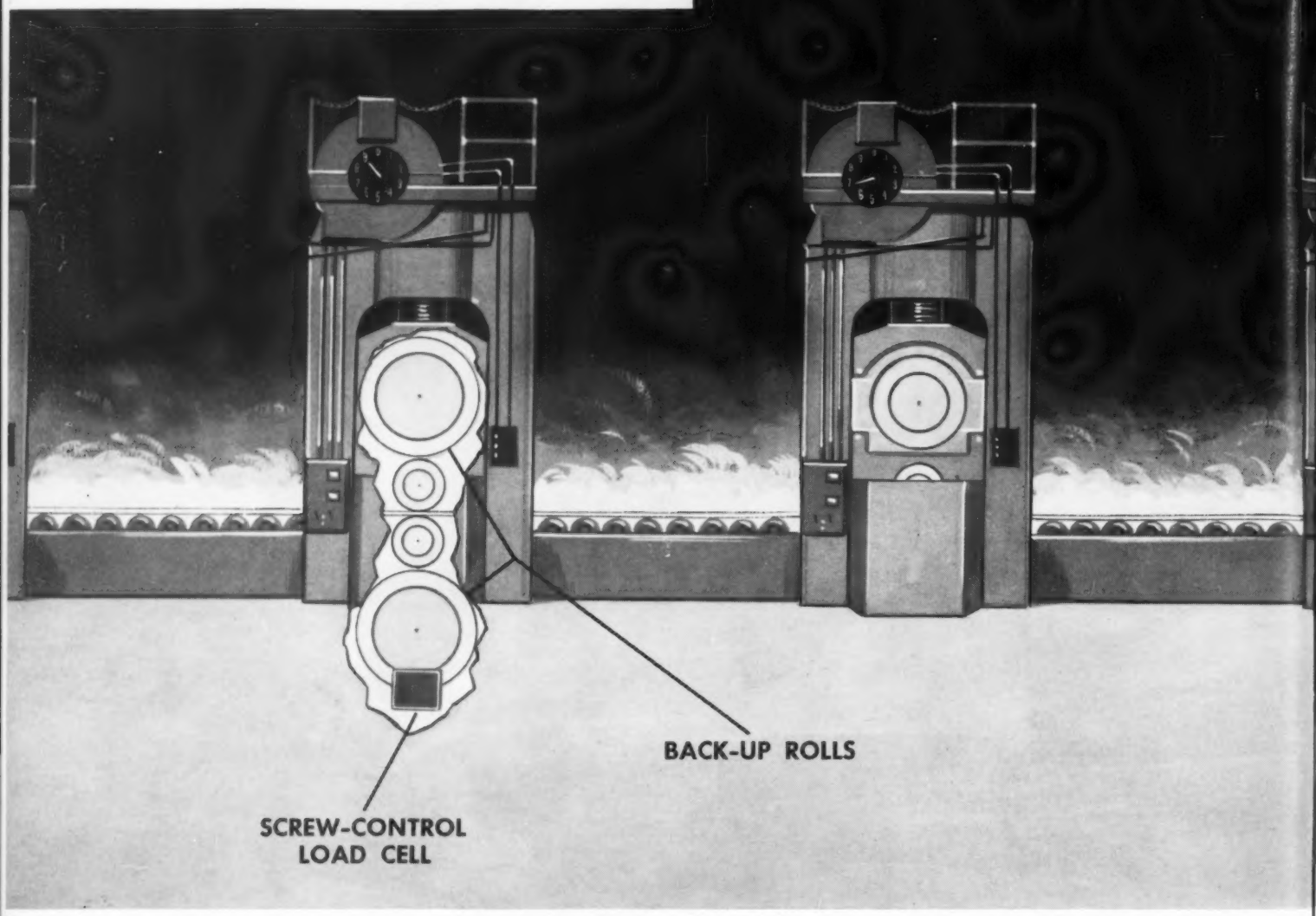
SEPTEMBER 27, 28, 29, 30 — 1960 • CLEVELAND PUBLIC AUDITORIUM

FOR QUALITY... PRODUCTIVITY ... PROFIT

METAL ROLLING
AUTOMATED BY GENERAL ELECTRIC



AT USS GENEVA WORKS

G-E automatic gage control maintains

A new, vastly improved method of automatically controlling gage on hot-strip mills is available now. Greater strip uniformity and increased yield per ton of steel will result from use of this thickness control system, developed jointly with U. S. Steel Corporation engineers, and now installed at USS's Columbia-Geneva Steel Division, Geneva Works, Provo, Utah.

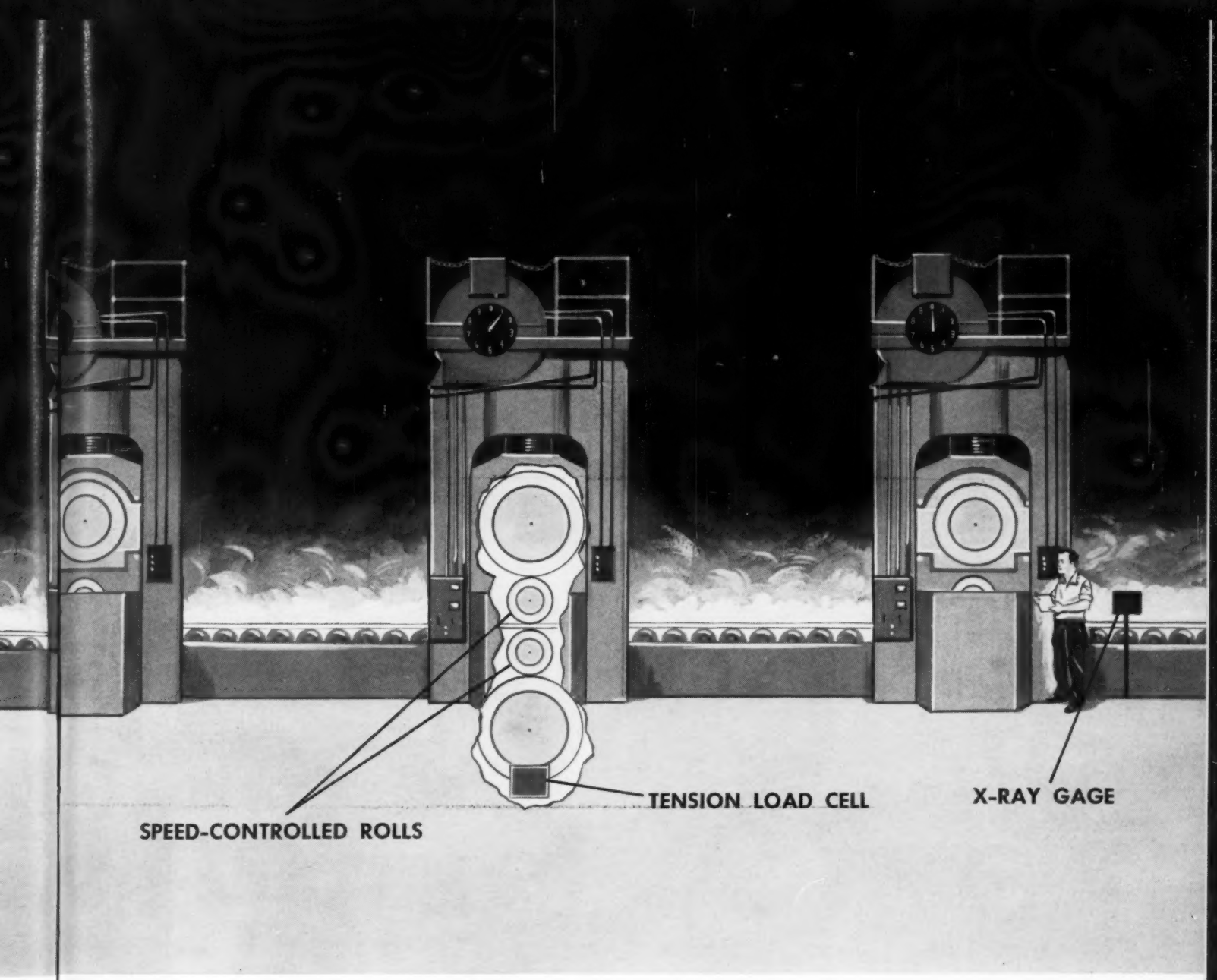
HOW UNIFORMITY AND YIELD ARE CONTROLLED

The system operates on the basis of off-gage steel automatically correcting itself by "triggering" the control to change the roll settings and inter-stand tension. As the temperature or gage of the strip being fed to the mill varies, the pressure against the rolls varies. At the second stand, this change in pressure is detected by the load cell where it is converted into power to move the screwdown motors. This entire operation is completely automatic and is initiated in a fraction of a second.

At the fifth stand, the same detection system is used to recheck the gage of the strip. However, at this point, the correction is made by adjusting the speed of the rolls, rather than their position. This controls the tension of the strip on either side of stand five, depending upon the correction required.

Automatic correction for hot and cold spots—As hot and cold spots pass through the mill, the control "feels" the difference in the hardness of the strip and automatically adjusts inter-stand tension to maintain a constant gage.

Strip "tail" is rolled to gage—The "tail" of the strip is often off-gage as a result of loss of tension as the end of the strip passes through the mill. The gage control



strip uniformity—increases yield

system adjusts the rolls or inter-stand tension to compensate for this loss of tension and rolls the "tail" to closer tolerance thickness, resulting in less scrap and greater yield.

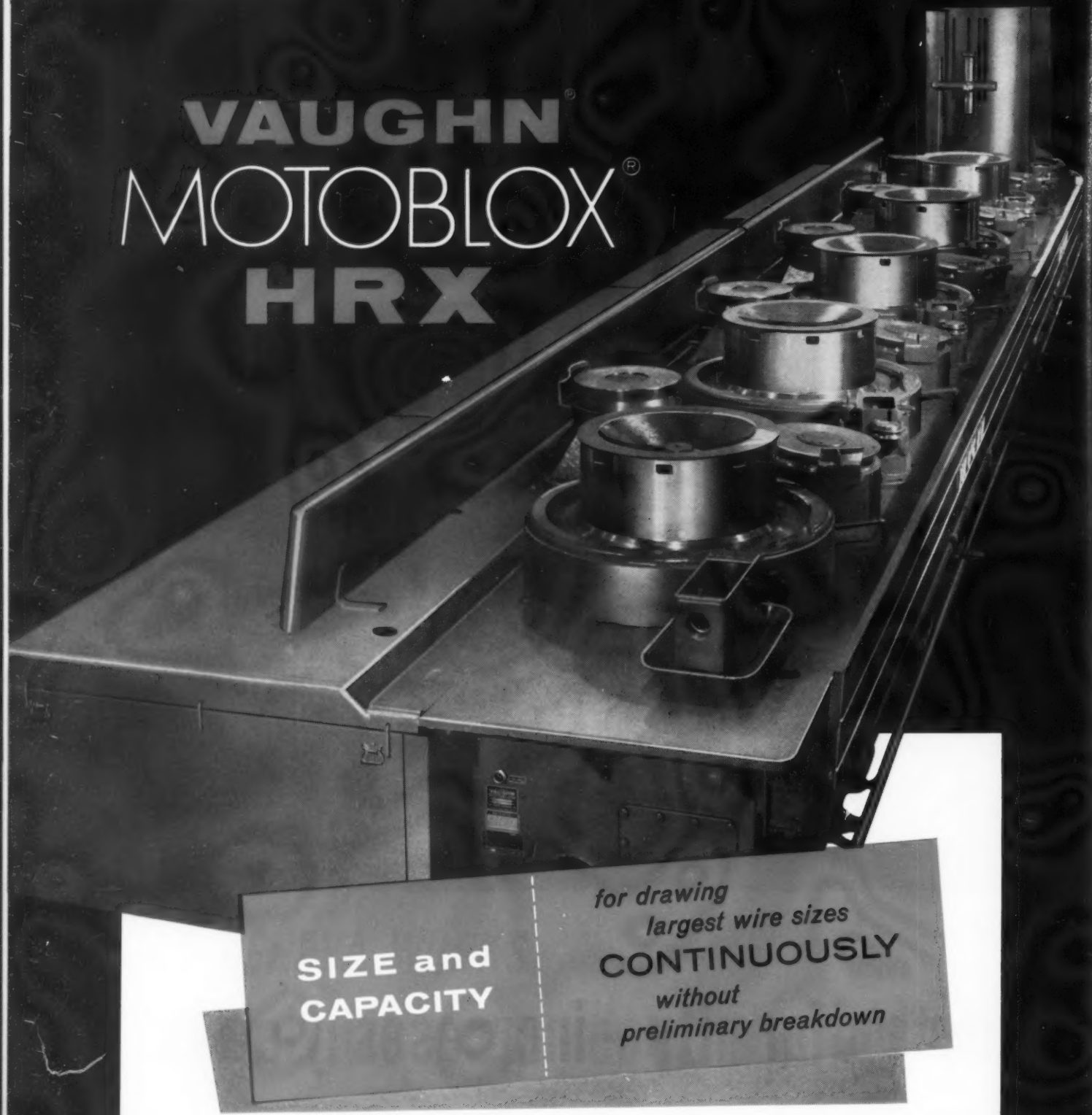
Automatic correction for long-time drift—An x-ray thickness gage is normally used in conjunction with the control. The x-ray continuously measures the gage of the strip, and automatically makes corrections to compensate for thermal effects and mill drift.

For complete details on this new gage control method, contact your G-E Apparatus Sales Engineer today, or write to Section 785-8, General Electric Company, Schenectady, N. Y., for bulletin GEA-6947. Industry Control Department, Salem, Virginia.

Progress Is Our Most Important Product

GENERAL ELECTRIC

VAUGHN® MOTOBLOX® HRX



SIZE and CAPACITY

for drawing largest wire sizes **CONTINUOUSLY** *without preliminary breakdown*

This is the big boy! Here is capacity in plenty to meet the ever-increasing demand for prestressed concrete wire and bridge wire at high production rates. The Vaughn HRX MOTOBLOX does a *double-cooled* (air *and* water) job of continuous operation on large wire sizes without preliminary breakdown—for instance, it will finish .70 carbon .192″ diameter wire from .437″ diameter rod at 1000 fpm. Equipped with 30″ intermediate blocks and 36″ finishing block, the Vaughn HRX can be obtained in packaged or conventional design. ● Let us give you the profit-making details!

THE VAUGHN MACHINERY COMPANY

Cuyahoga Falls, Ohio, U. S. A.

COMPLETE COLD DRAWING EQUIPMENT . . . Continuous or Single Hole . . . for the Largest Bars and Tubes . . . for the Smallest Wire . . . Ferrous, Non-Ferrous Materials or their Alloys.

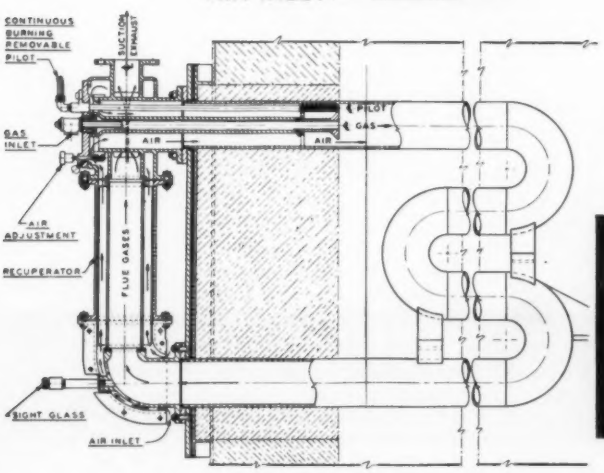
Efficient... Dependable

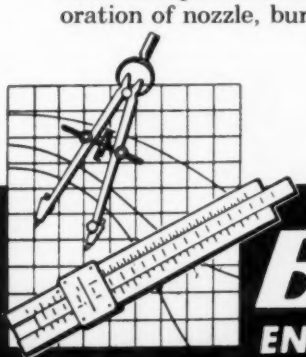
Note compact arrangement of gas inlet, flue gas exhaust, sight glass and fixed externally-lighted pilot.

The BLOOM RECUPERATIVE RADIANT TUBE BURNER

The drawing below shows how the BLOOM RADIANT TUBE BURNER can be mounted on the tube outside of the furnace, without danger of tube overheating. Nozzle is at inside edge of furnace wall. Design provides uniform tube temperature without hot spots, regardless of flow. Recuperator preheats air 600° to 800°F. Operates on clean or dirty coke oven gas, natural gas or butane. Continuously burning pilot assures positive ignition.

One installation was dismantled for inspection after a year's operation on coke oven gas, at furnace temperature of 1750°F. Conditions found were: clean nozzle, clean recuperator, clean "W" radiant tube, no deterioration of nozzle, burner parts or pilot burner.





WRITE for complete details of the BLOOM RADIANT TUBE BURNER

BLOOM ENGINEERING CO., INC.

857 W. North Avenue Pittsburgh 33, Pa.

Behind every EC&M controlled installation...

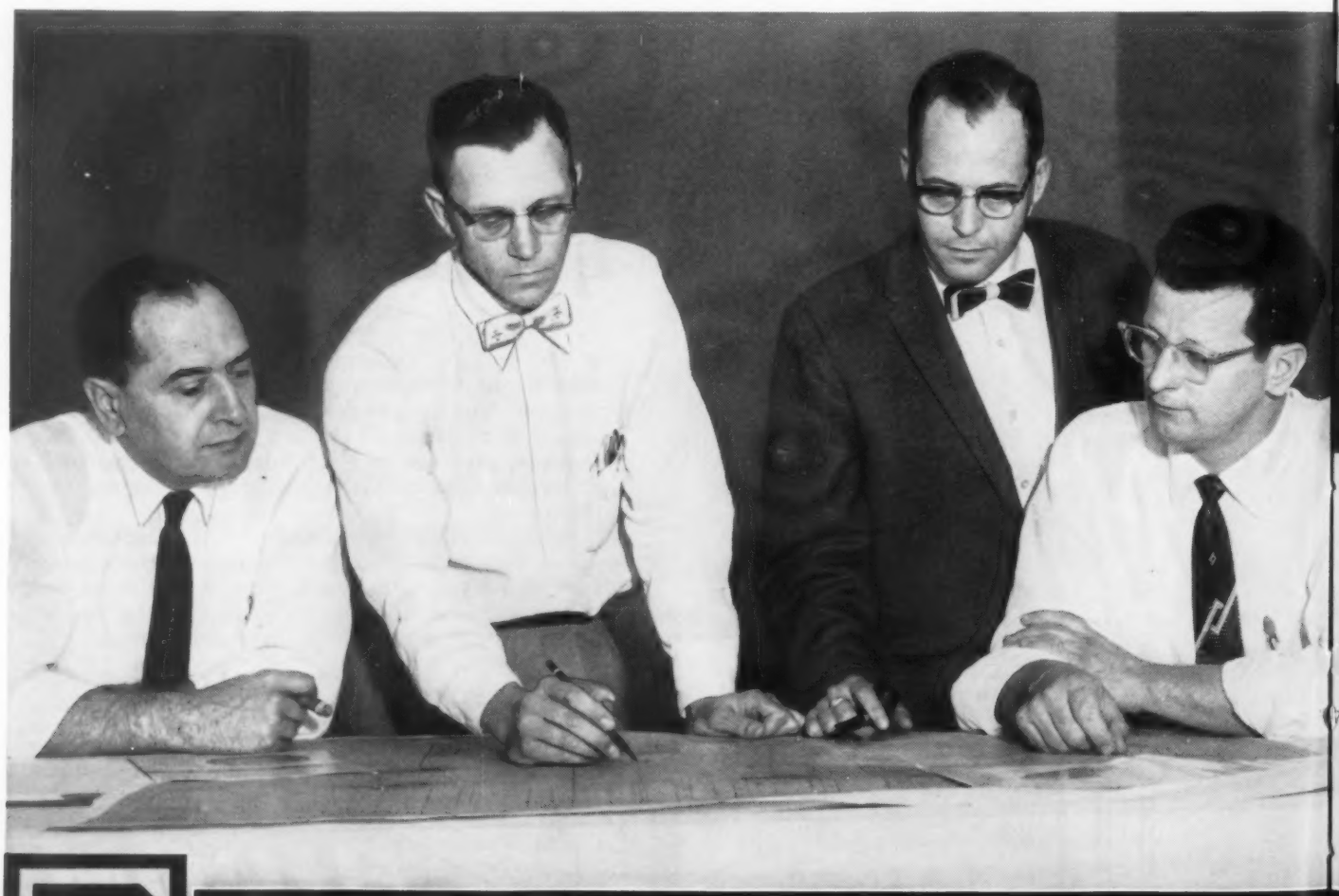
...an EC&M engineering team coordinated their knowledge and experience to design the control system best suited for that particular installation.

EC&M's engineering team studies every facet of an installation...nothing is taken for granted. Then, and only then, is a control system designed.

Advance planning of this type has two important advantages. First, the "tune-up" time of the installation is practically eliminated. Secondly, future maintenance is substantially reduced.

No matter what your requirements may be ...adjustable voltage or constant potential, an ore bridge or an automatic rolling mill control system...EC&M engineering counsel is available to you without obligation.

It will pay you to call EC&M into consultation early, when planning your next installation.



SQUARE D COMPANY

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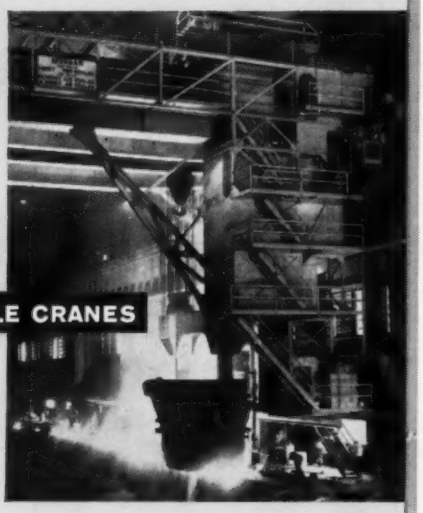
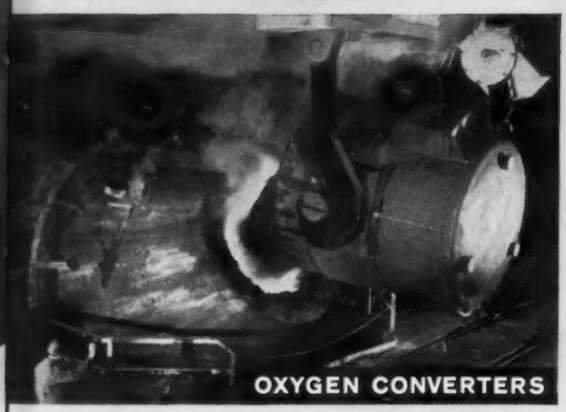
Installations Equipped with an EC&M Control System

OVERHEAD CRANES

ROLLING MILLS

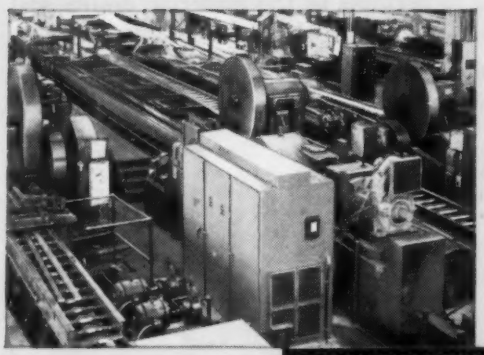


LADLE CRANES



OXYGEN CONVERTERS

ORE UNLOADERS



DRAW BENCHES

There's an EC&M Control System to fit every application or installation

Material Handling

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- Ore Bridges
- Unloaders
- Conveyors
- Car Dumpers
- Aerial Tramways
- Hoists:
  - Skip
  - Mine
  - Slope

Rolling Mills

- Blooming
- Slabbing
- Plate
- Rail
- Beam
- Billet
- Bar
- Rod Merchant

Steel Mill Machinery

- Ingot Buggies
- Screwdowns
- Edgers
- Feed Rolls
- Sideguards
- Manipulators
- Table Rolls
- Transfers
- Coilers
- Oxygen Vessels

Steel Mill Accessories

- Planers
- Lathes
- Boring
- Milling Machines
- Presses
- Scalpers

Processing Lines

- Slitting
- Leveling
- Welding
- Shearing
- Cleaning
- Scrubbing
- Temper Pass
- Reducing Mills
- Wire Drawing
- Draw Benches
- Tube Mills

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3522

This is THERMAL FATIGUE

This photograph shows a heat-resistant alloy casting after thermal-fatigue failure.

Thermal fatigue begins with cyclical heating and cooling which produces alternate expansion and contraction. The shape of the casting hinders this expansion and contraction. As a result, hindered expansion and contraction stresses develop and increase until plastic flow occurs. This plastic flow produces a network of thermal-fatigue cracks and this cracking leads to failure.

Thermal fatigue is an inherent problem in heat-resistant castings. As such, it occupies an important place in Electro-Alloys research efforts to lengthen life of components working under high temperatures and severe cyclical conditions.

We have created apparatus that assesses and analyzes the variables of thermal fatigue. Check with your Electro-Alloys representative for the meaning of our thermal fatigue data as it pertains to the material, design and service conditions of your heat-resistant castings.

Send for free technical booklet on Thermal Fatigue

Please send me free copy of "The Mechanism of Thermal Fatigue," by Howard S. Avery—comprehensive report based on extensive lab studies:

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Electro-Alloys, 2033 Taylor St., Elyria, Ohio

AMERICAN Brake Shoe COMPANY

ELECTRO-ALLOYS DIVISION • Elyria, Ohio

patent reviews

By MELVIN NORD, Patent Attorney, Detroit, Mich.

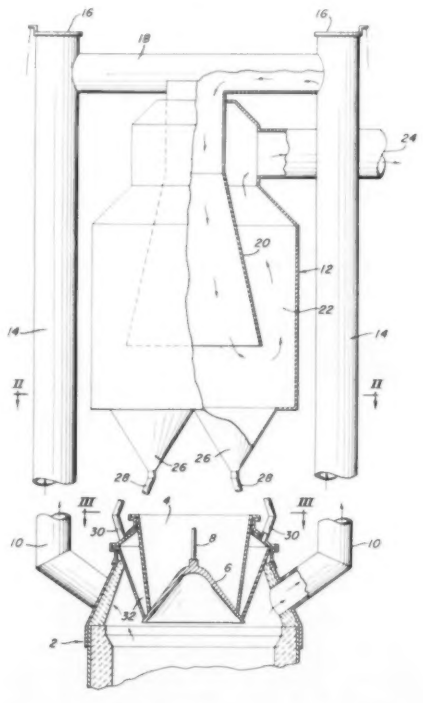
Copies of patents may be obtained from the Commissioner of Patents, Washington 25, D. C. at 25 cents . . . patents reviewed cover period September 22, 1959 to October 20, 1959.

CHARGING FLUE DUST INTO A BLAST FURNACE

△ U. S. 2,906,520, issued Sept. 29, 1959, to Henry W. Hochberger, assigned to United States Steel Corp., provides apparatus for automatically charging flue dust into a blast furnace without sintering, in such a manner that a large portion of the flue dust will remain in the furnace.

As shown in Figure 1, the blast furnace gas passes continuously from the top of the blast furnace 2 to the dust catcher 12 where the flue dust is continuously separated out into the hoppers 26. From here the dust passes through conduits 28 and 30 to the secondary hopper 32.

Figure 1



When the burden has been charged to the top of the big bell hopper the big bell 6 is lowered and the burden along with the flue dust in the hopper 32 passes downwardly into the furnace 2. The big bell 6 is then raised to close the hoppers 4 and 32 and the charge of coke, iron ore and limestone is charged onto the big bell 6 from the small bell in the usual manner. The operation is then repeated.

HOT DIP METALLIC COATING OF STEEL STRIP

△ U. S. 2,906,018, issued Sept. 29, 1959, to Thomas W. Baker, assigned to Armco Steel Corp., provides a finishing machine for use in the hot dip metallic coating of steel strip at very high speeds.

The invention is based upon the discovery that nonwetting rolls are not subject to the speed limitations of wetted rolls, but will continue to squeegee excess tin from the strip surfaces at very high speeds, even up to 1000 fpm or more, while continuing to produce coatings as light as 1¼ lb per base box or lighter.

In Figure 2, a tin bath is indicated at 10 and a hood through which the strip enters the pot is indicated at 11. The strip itself is indicated at 12. It will be understood that the strip has previously been prepared for the coating process, as for example by oxidation and reduction, and protection from the atmosphere until it is introduced into the bath through the hood 11. The strip passes over a bottom roll 13 and then upwardly through the skimming rolls 14. The rolls 14 are partially submerged in the molten

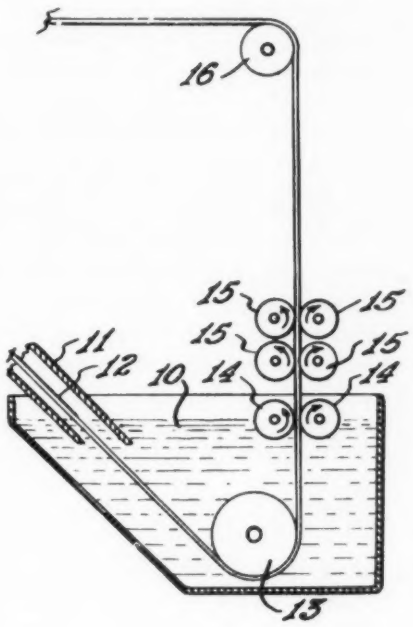


Figure 2

coating metal.

At 15, pinch rolls of a nonwetting material are shown between which the strip passes and the strip will then travel vertically upwardly for such a distance as will insure that the coating has frozen before it changes direction by passing over a roll 16.

The nonwetting rolls 15 act as squeegees and remove from the strip any excess of coating metal. Thus, if the rolls 15 are under sufficient pressure and are sufficient in number, it is possible to squeegee off the strip substantially all of the virgin tin which has not alloyed with the base metal so that the surface will be constituted of the iron-tin alloy using about 0.2 lb of tin per base box.

Such material having an iron-tin

alloy surface is useful in many applications. It can be soldered and can therefore be used without further processing in many dry pack applications. It can also be given a protective coating of lacquer and is then comparable to lacquered electrolytic tinplate.

PRODUCTION OF INSULATIVE COATINGS ON SILICON STEEL STRIP

△ U. S. 2,906,645, issued Sept. 29, 1959, to Victor W. Carpenter and John M. Jackson, assigned to Armco Steel Corp., provides a method of applying a refractory annealing coating on silicon steel strip in such a way as not to recarburize the steel or to oxidize it excessively.

As shown in Figure 3, the numeral 10 represents a hopper into which magnesia is fed. The hopper is agitated by an electromagnetic vibrator 11 so that the magnesia is continuously and slowly fed onto a vibratory feeder 12. The magnesia slowly feeds off the end of the vibratory feeder 12 into the mixing tank 13. Water is added at a controlled rate through the line 14. The water and magnesia are mixed by means of a mixing device 15. The slurry passes out through a line 16 to a motor driven pump 17 and through a line 18 to a T-fitting 19. From here the slurry passes from the lines 20 and 21 to the nozzles 22 and 23 by which it is sprayed onto both sides of the strip 24 simultaneously. Splash shields are preferably provided at 25.

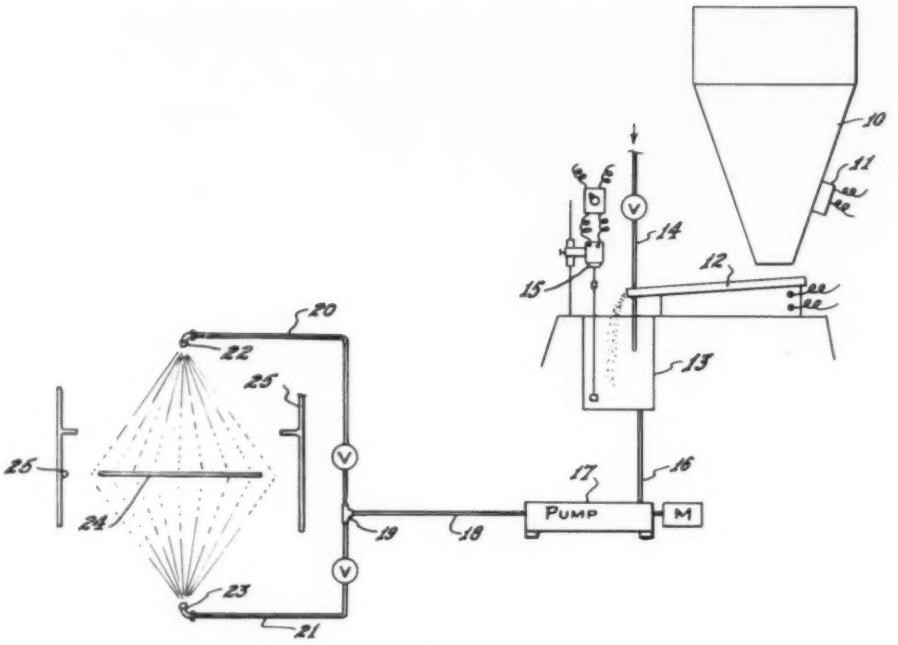


Figure 3

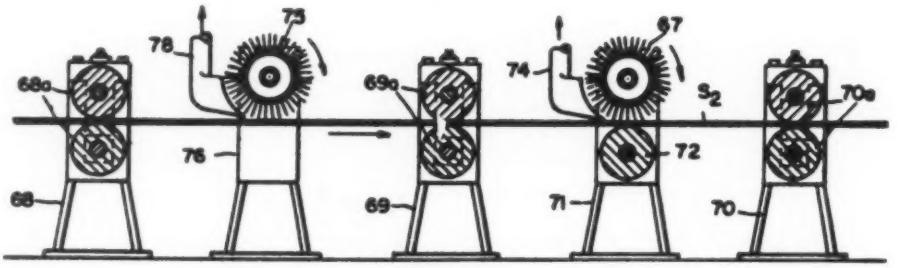


Figure 4

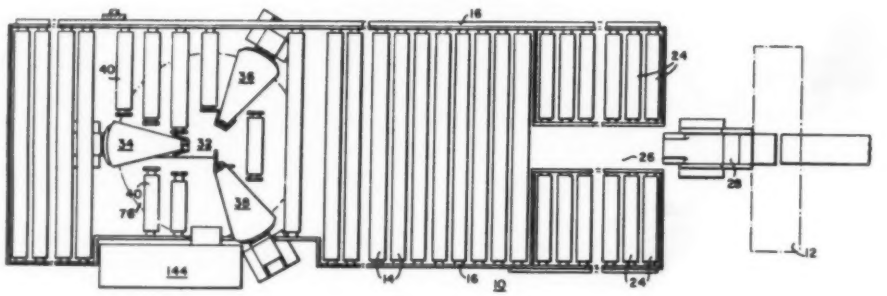


Figure 5

CONDITIONING METAL SHEETS

△ U. S. 2,907,151, issued Oct. 6, 1959, to Ruben O. Peterson, assigned to the Osborn Manufacturing Co., relates to the conditioning of metal sheets, strip or rod by a brushing action, with the application of an abrasive material so as to remove scale, small slivers and other objectionable surface irregularities.

It has been found that if the abrasive material is forcibly discharged onto the surface of a sheet simultaneously with the application of a brush, the cleaning action is greatly reduced and the power required for brushing is greatly reduced. The rotary brush itself may be used to discharge, by centrifugal action, the abrasive material onto the surface. The sheet is also subjected, prior to brushing, to a stretching operation whereby the sheet is elongated about 7 per cent. A fine bright, scale-free finish can thus be produced.

Figure 4 shows the apparatus schematically.

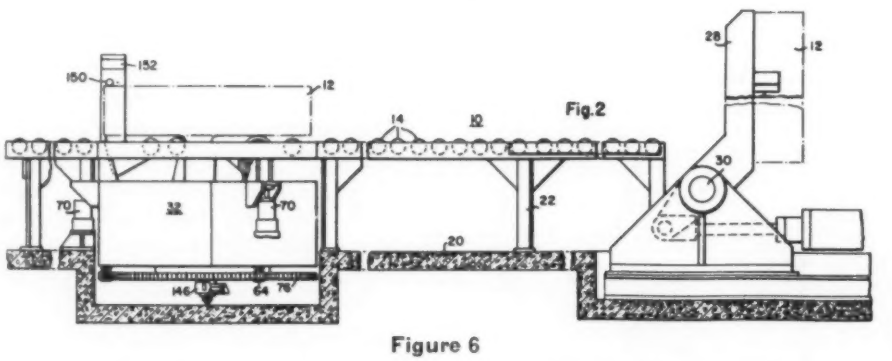


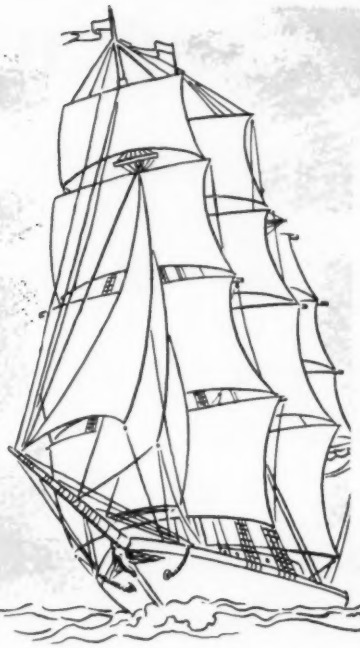
Figure 6

APPARATUS FOR HANDLING SLIT STRIP COILS

△ U. S. 2,905,078, issued Sept. 22, 1959, to Edward A. Laine and assigned to Allegheny Ludlum Steel Corp., relates to apparatus for

Why Rust-Oleum is different—

and what this difference, backed by 35 years of industry proof, means to you!



A Sea Captain developed it . . . Industry proved it!

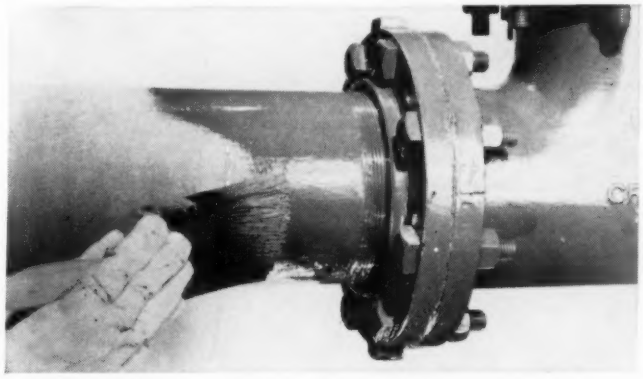
The original Rust-Oleum formula was developed nearly fifty years ago by Sea Captain Robert Fergusson, who became intrigued with the rust-stopping qualities of fish oil early in his career. Creating a *special treatment* for the fish oil, he used the *specially-processed fish oil* as the vehicle in combination with fine rust-inhibiting pigments. The result? A coating that actually *stopped rust* when applied directly over sound rusted surfaces, after scraping and wirebrushing to remove rust scale and loose rust. Possible, because the *specially-processed* fish oil penetrated the rust to bare metal. This was the birth of Rust-Oleum's *exclusive* 769 Damp-Proof Red Primer.

PROVED THROUGHOUT INDUSTRY FOR OVER 35 YEARS

Today, Rust-Oleum in its many systems and colors, has been proved throughout industry for over thirty-five years. This proof by leading industrial users is your assurance of savings in time, money, and metal. Economies made possible by the fact that Rust-Oleum 769 Damp-Proof Red Primer goes right over the sound rusted metal—usually eliminating costly surface preparations. And Rust-Oleum, in its various systems, resists rain, sun, fumes, heat, weathering, chemicals, etc., for lasting beauty over the years.

RUST-OLEUM NEW COLOR HORIZONS SYSTEM

The Rust-Oleum New Color Horizons System introduces a new coating concept to industry. It combines four important factors: (1) the ability to stop rust, (2) smart, modern color harmony, (3) the durability to last and last, (4) ease of application that saves time, money, and metal. See how this system can bring lasting beauty to your plant, machinery, equipment, pipes, tanks, structural steel, fences, etc. Write for complete information or contact your nearby Rust-Oleum Industrial Distributor. He maintains complete stocks for prompt service.



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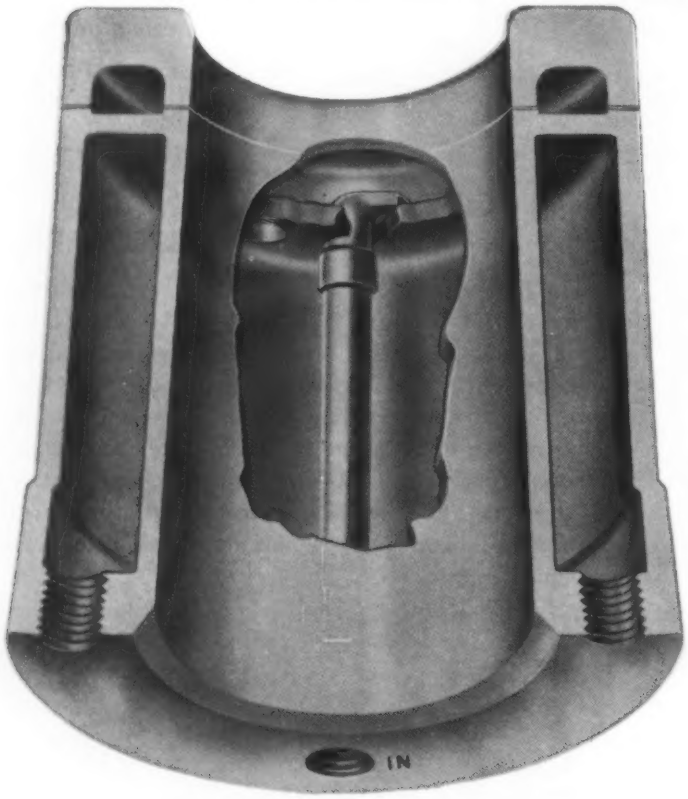

give you service-proved savings: tuyere life increased 500% . . . tuyere cost per ton of iron cut 77% . . . iron lost due to tuyere failure down 73%.

- Efficient cooling design circulates water completely around the nose section first: machined waterway gives maximum heat transfer, prevents clogging and algae build-up.
- Replaceable nose of two-piece construction lets you salvage 80% of tuyere weight when nose wear occurs.
- Highest conductivity of forged OFHC copper nose with certified minimum conductivity of 98%; cast virgin electrolytic copper body has certified 90% conductivity.

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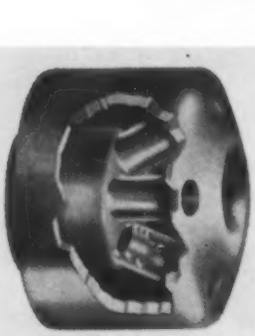
*U. S. Patent No. 2,891,783 Bethlehem Steel Company

**Patent applied for



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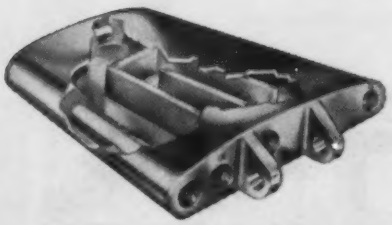
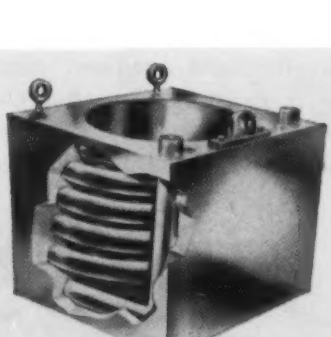


BOSH PLATES. Long life, lower maintenance assured by dual cooling chamber design. Chambers can be independently operated.



ROOF COOLERS FOR OXYGEN LANCING. High cooling efficiency comes from design with copper tubing cast into copper block.** Resists corrosion and algae build-up.

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handling slit strip coils of steel for facilitating its banding, without introducing strains into the strip.

As shown in Figures 5 and 6, a wound coil 12 is loaded on a rotatable arm 28 from a suitable source of supply and the arm 28 is moved from a vertical position to a horizontal position to deposit the wound coil 12 on the rollers 24. With the switch 152 in a circuit closing position, the motor is energized to actuate the rollers 14 and move the wound coil of steel to a point where the wound coil 12 is disposed over the conical rollers 34, 36, and 38. As long as a coil 12 is not positioned over the conical rollers, the limiting mechanism 150 is not operated and the switch 152 is placed in a circuit closing position. When the wound coil 12 contacts the limiting mechanism 150, the limit switch 152 is operated to its circuit interrupting position to stop the operation of the motor and consequently the operation of the rollers 14 of the conveyor system.

With the wound coil 12 disposed over the conical rollers 34, 36 and 38, a contact member is manually operated to a position where fluid pressure is admitted to the lifting cylinders 70 to effect an upward movement of the rollers 34, 36 and 38 whereby the upper contacting surfaces engage the wound coil 12 to lift the wound coil 12 above the plane of movement of the rollers of the conveyor system 10. When the coil 12 is supported in this manner the banding machine 144 is moved into a banding position to band the wound coil in one position. When such a banding operation is completed, the manually operated contact member is actuated to a circuit closing position whereby an energizing circuit is established to carry the coil 12 to its next banding position.

DESULPHURIZATION OF LIQUID PIG IRON

△ U. S. 2,906,616, by Marc Allard, Bernard Trentini and Lucien Wahl, and U. S. 2,906,617, by Lucien Wahl, issued Sept. 29, 1959, and assigned to Institut de Recherches de la Siderurgie, describe processes for desulphurizing liquid pig iron.

As shown in Figure 7, the plant includes chiefly an apparatus 1 in the shape of a converter adapted to be tilted round its axis 2, a

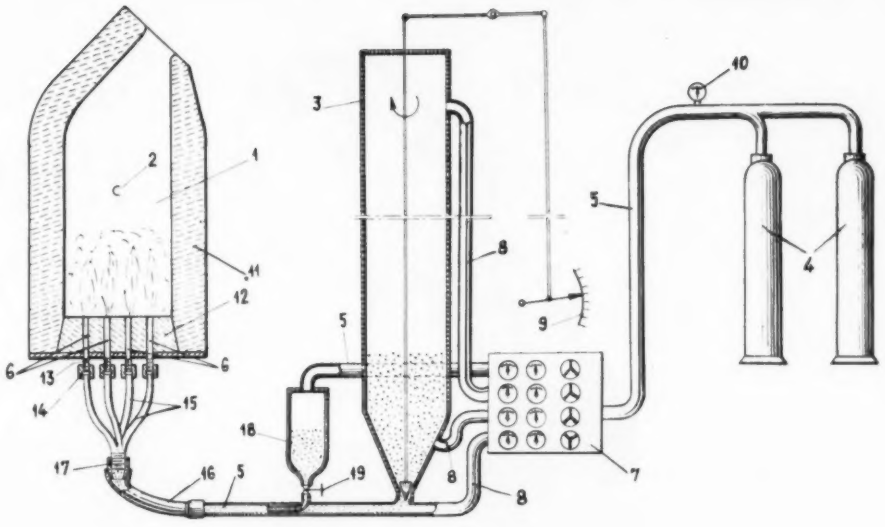


Figure 7

powder-distributor 3 in feeding uniform outputs of highly concentrated suspensions of a very fine powder, a group of bottles 4 containing compressed nitrogen, a pipe 5 feeding the nitrogen with the subsequent admixture of the desulphurizing reagent to the tuyeres 6 extending through the bottom of the converter and a control board 7 for checking and adjusting operation.

IMPROVING THE QUALITY AND PRODUCTIVITY OF ELECTRIC ARC FURNACE STEEL

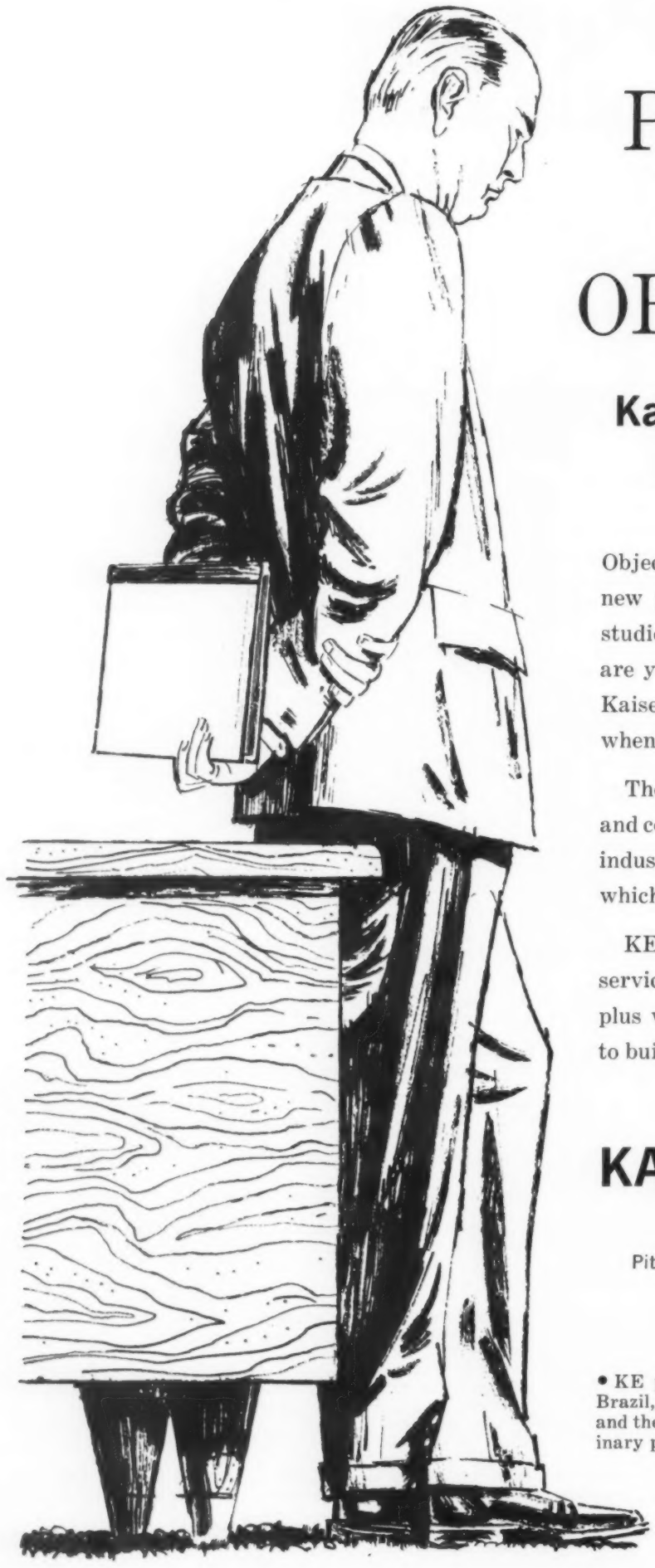
△ U. S. 2,909,422, issued Oct. 20, 1959, to William E. Schwabe and assigned to Union Carbide Corp., describes a method of improving the quality of product from and productivity of electric arc furnaces.

According to the present invention, means are provided for controlling the arc stability of a hollow carbonaceous electrode. The bore of the electrode is supplied with argon gas, and arc-modifying materials are periodically entrained in the gas to shorten, lengthen, sustain or suppress the arc of the electrode.

This stream of material also counteracts the updraft which normally prevails in hollow electrodes, and reduces considerably the electrode consumption.

OTHER PATENTS OF INTEREST TO THE IRON AND STEEL ENGINEER

Patent No.	Date	Subject	Inventor or assignee
2,905,577	9/22/59	Creep resistant chromium steel....	The Birmingham Small Arms Co. Ltd.
2,905,997	9/29/59	Safety lock for crane hook.....	United States Steel Corp.
2,906,521	9/29/59	Sealing means for degassing vessels	Dortmund-Horder Huttenunion A.G.
2,906,565	9/29/59	Bearing seal for rolling mill roll....	United States Steel Corp.
2,906,651	9/29/59	Production of malleabilized castings	Regie Nationale des Usines Renault
2,906,652	9/29/59	Production of bright-finished steel strip.....	United States Steel Corp.
2,906,653	9/29/59	Die-casting of iron in chill-moulds..	Regie Nationale des Usines Renault
2,906,677	9/29/59	Electrolytic treatment of tinplate...	National Steel Corp.
2,907,083	10/6/59	Splash mat for ingot molds.....	Jones & Laughlin Steel Corp.
2,907,235	10/6/59	Cold rolling mills.....	Yoshihiko Murakami
2,907,236	10/6/59	Cooling bed.....	Birdsboro Steel Foundry & Machine Co.
2,907,652	10/6/59	Method of treating open hearth steel	The Dow Chemical Co.
2,907,698	10/6/59	Producing coke from coke breeze and coal.....	Erich Schulz
2,908,055	10/13/59	Ladle maintenance safety cage....	Sticker Industrial Supply Corp.
2,908,361	10/13/59	Surface and pit furnace safety maintenance cage.....	Sticker Industrial Supply Corp.
2,908,407	10/13/59	Blast furnace distributor seal.....	Interlake Iron Corp.
2,908,737	10/13/59	Smoke suction installation for electric metal melting furnaces.....	Giovanni de Dominicis
2,909,272	10/20/59	Reversible idle for conveyor belts..	Jones & Laughlin Steel Corp.
2,909,425	10/20/59	Austenitic steels for high temperature service.....	Crucible Steel Co. of America
2,909,454	10/20/59	Producing core-plated electrical steel strip.....	United States Steel Corp.



PROCEED, DEFER OR MODIFY?

Kaiser Engineers can help you decide

Objective analysis is vital to sound decision on new plant or expansion projects. Feasibility studies, economic analyses and site evaluations are yours by an outside, impartial firm when Kaiser Engineers is selected to help you decide when, how and where to proceed.

These services are in addition to the design and construction of major facilities for the Steel industry—including the proven L-D Process for which KE is the U. S. licensor.

KE offers complete, one-company, integrated service from concept through construction—plus world-wide experience and the ingenuity to build quickly, within budget.

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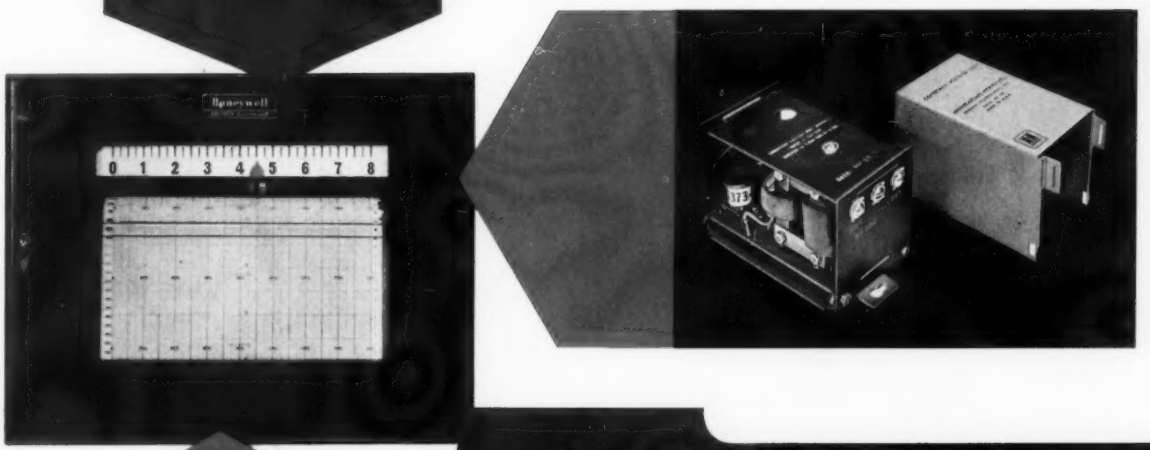
• KE projects include work in Argentina, Australia, Brazil, Formosa, Japan, New Zealand, as well as Canada and the United States. Assignments range from preliminary planning to plant construction.

5458-S

MODULAR DESIGN MAKES 1960 *Electronik* POTENTIOMETERS A GREATER VALUE THAN EVER

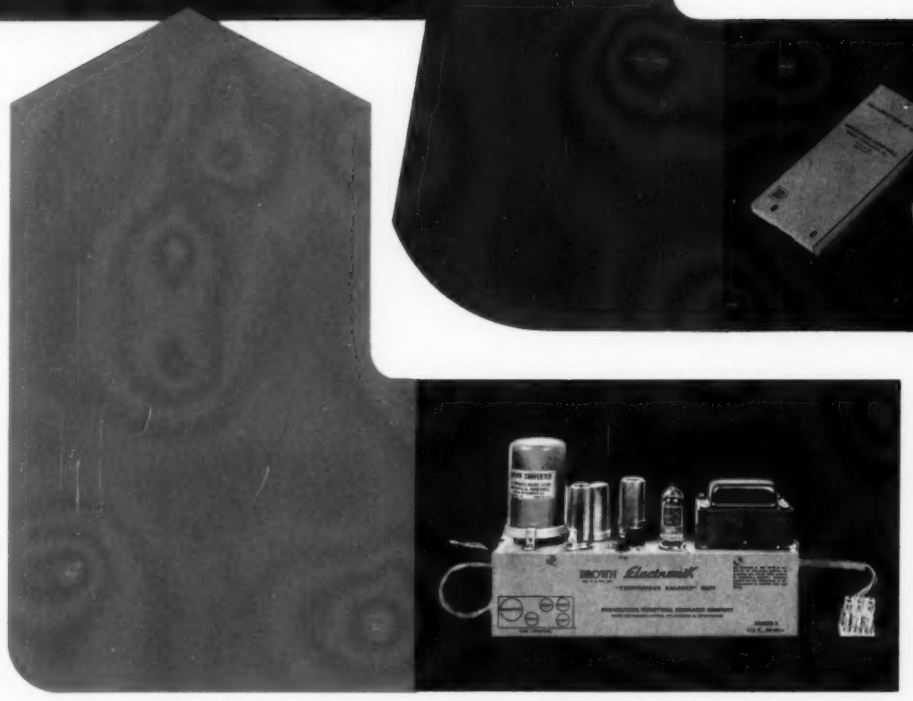
BALANCING AND CHART DRIVE MOTORS are sectionalized. Service is simplified because any major part can be replaced in a matter of seconds.



CONSTANT VOLTAGE UNIT* eliminates need for batteries, standard cells, and standardizing mechanisms . . . insuring long life.

*Zener Diode

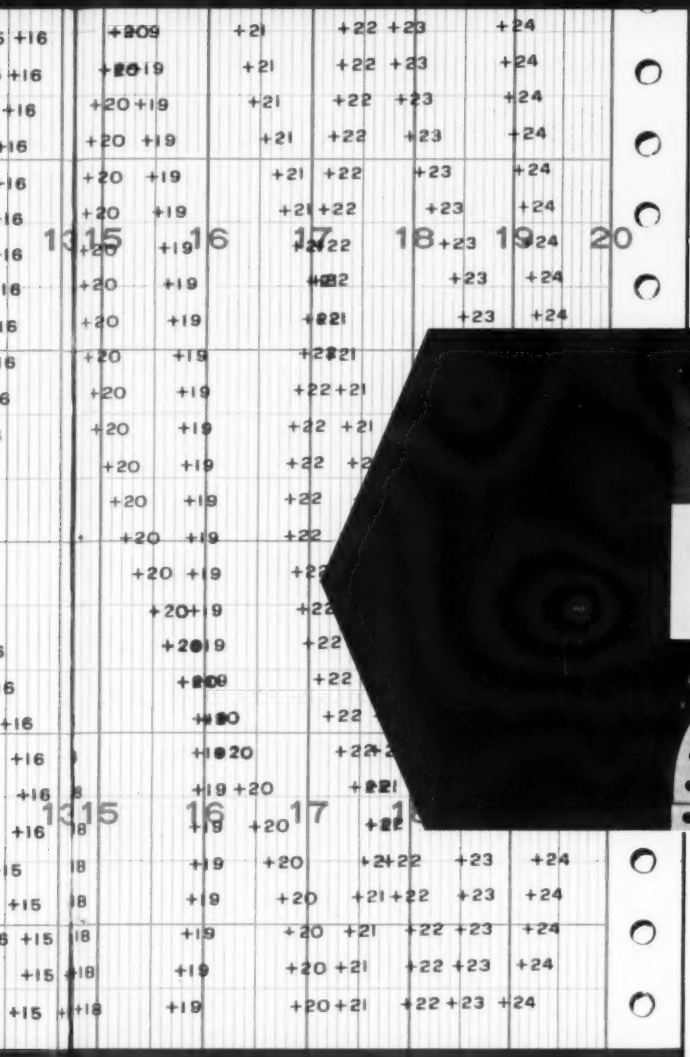
COMPARTMENTED MEASURING CIRCUIT UNIT makes range changing easy. Change one screw on a clip connected card of fixed resistors, and the job is done in a matter of seconds.

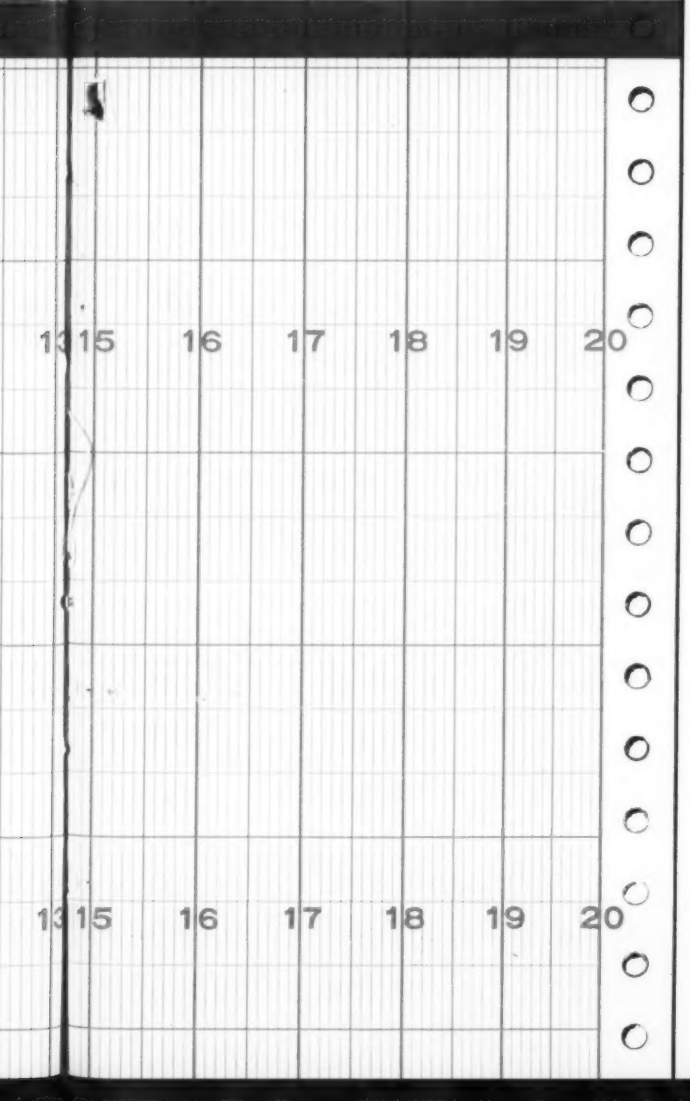


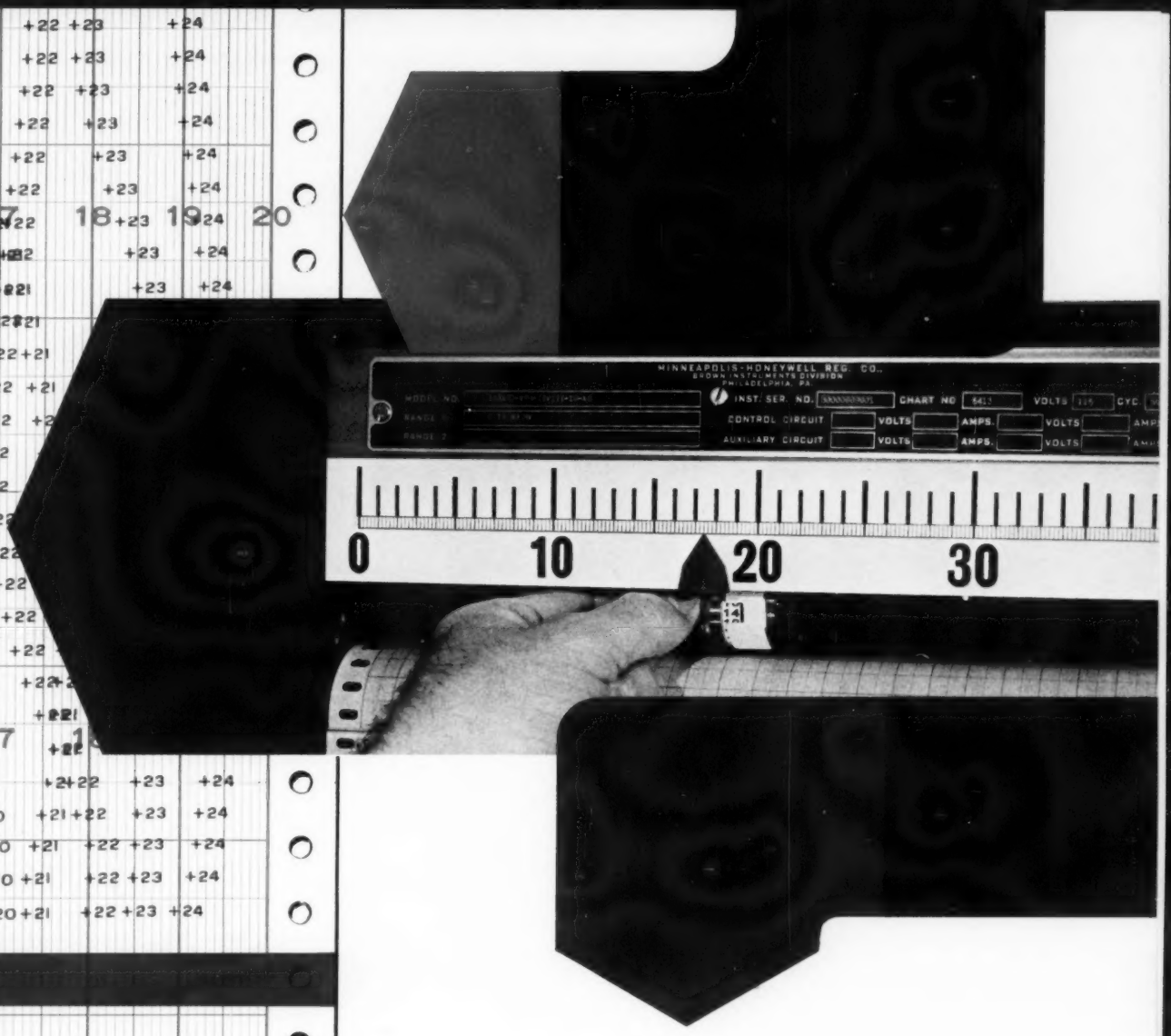
QUICK-CONNECT AMPLIFIER is easily removed from the instrument by means of a polarized plug.

BUT THIS IS JUST PART OF THE STORY OF THE 1960 LINE OF ELECTRONIK POTENTIOMETERS. LOOK AT THE DRASTIC CHANGES IN THE ELECTRONIK MULTI-RECORD RECORDERS.

HUNDREDS OF DEGREES FAHRENHEIT
0 1 2 3 4 5 6 7 8 9 10 11 12 13 15
HUNDREDS OF DEGREES FAHRENHEIT
0 1 2 3 4 5 6 7 8 9 10 11 12 13 15
HUNDREDS OF DEGREES FAHRENHEIT
0 1 2 3 4 5 6 7 8 9 10 11 12 13 15
HUNDREDS OF DEGREES FAHRENHEIT
0 1 2 3 4 5 6 7 8 9 10 11 12 13 15
PLATE 268
INTED IN U.S.A







Record 2 to 24 points on one instrument with new UNIVERSAL *ElectroniK*

MULTI-RECORD INSTRUMENT

Now, you can record 2,3,4,6,8,10,12,16,20, or 24 points on one ElectroniK Multi-Record Instrument . . . and change the number of points to be recorded in a matter of seconds. It's easy as this: remove a thumb-tight nut and slip off old print wheel . . . and indicator dial. Slip on a new wheel and dial: Replace nut. Plug in the number of points desired, and the job is done.

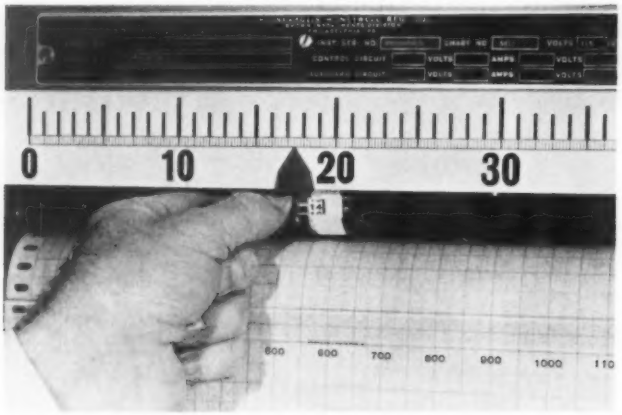
The universal features and modular design of the 1960 line of ElectroniK potentiometers are standard on all multi-record non-control models. Range and compensation changes are quick and easy, too . . . just change the cards.

FROM HONEYWELL... A DIAMOND JUBILEE PARADE OF PRODUCTS

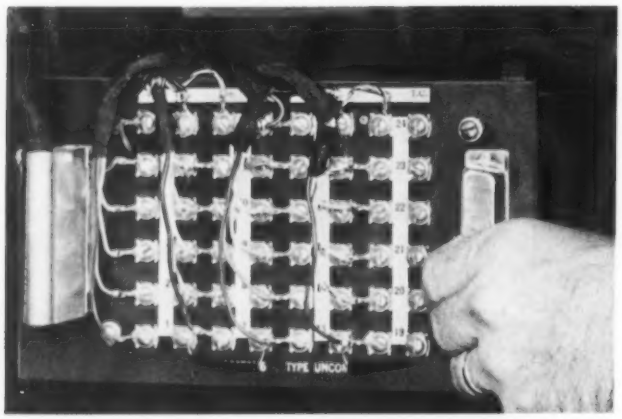
SEE HOW EASY THE 1960 ELECTRONIK MULTI-POINT RECORDERS ARE TO USE...

all it takes with the 1960 *ElectroniK* MULTI-RECORD RECORDERS to change . . .

. . . number of points recorded



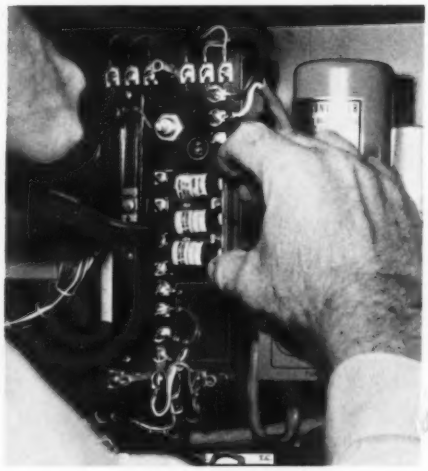
First: remove thumb-tight nut; slip off print wheel and indicator dial. Slip on new wheel and dial and replace nut.

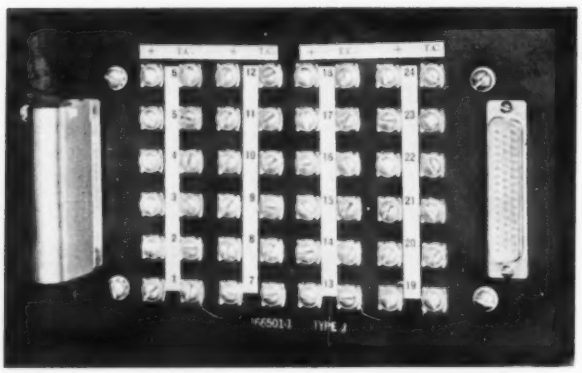


Second: replace one plug-in unit and the instrument is ready to record a different number of points.

The new flexibility and convenience of the 1960 ElectroniK Multi-Record Recorders should interest you. This new design has resulted in substantial manufacturing cost reductions which are reflected in our new price structure. Your nearby Honeywell field engineer has the full details. He's as near as your telephone. Minneapolis-Honeywell, Wayne and Windrim Avenues, Philadelphia 44, Pa.

. . . RANGE—Loosen screws and slide out the range resistor card. Replace with a different card, tighten screws and the job is done quickly and easily.





. . . COMPENSATION—The input terminal board with built-in reference junction comes out by removing one plug. Slide in the new board, replace the screws and plug and the compensation is changed.

Honeywell

First in Control

SINCE 1885

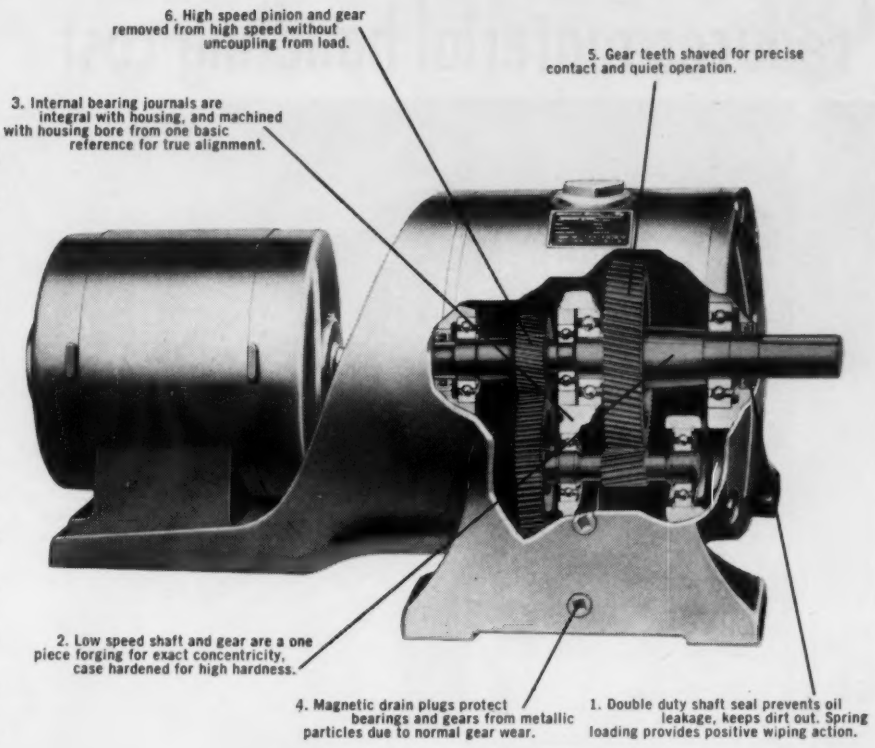
75th YEAR

PIONEERING THE FUTURE

on the long run...

QUALITY COSTS YOU LESS!

And some of the features illustrated here tell why. Accurate tooth loading through precise gearing, freedom from distortion under load and accessibility from either end are a few of the reasons why the Western Gear StraitLine Gearmotor is considered a standard of quality wherever it goes. Your nearby Western Gear sales engineer is ready to supply you with additional information for your next application. And for a starter, use the coupon in this ad to get our basic bulletin No. 5806-F.


6. High speed pinion and gear removed from high speed without uncoupling from load.
5. Gear teeth shaved for precise contact and quiet operation.
3. Internal bearing journals are integral with housing, and machined with housing bore from one basic reference for true alignment.
2. Low speed shaft and gear are a one piece forging for exact concentricity, case hardened for high hardness.
4. Magnetic drain plugs protect bearings and gears from metallic particles due to normal gear wear.
1. Double duty shaft seal prevents oil leakage, keeps dirt out. Spring loading provides positive wiping action.

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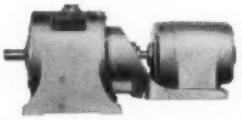
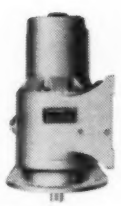
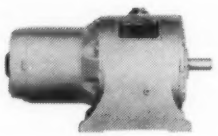


SHOVEL-BASE GEARMOTOR

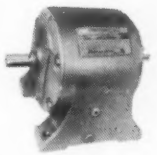


VERTICAL GEARMOTOR



INTEGRAL GEARMOTOR

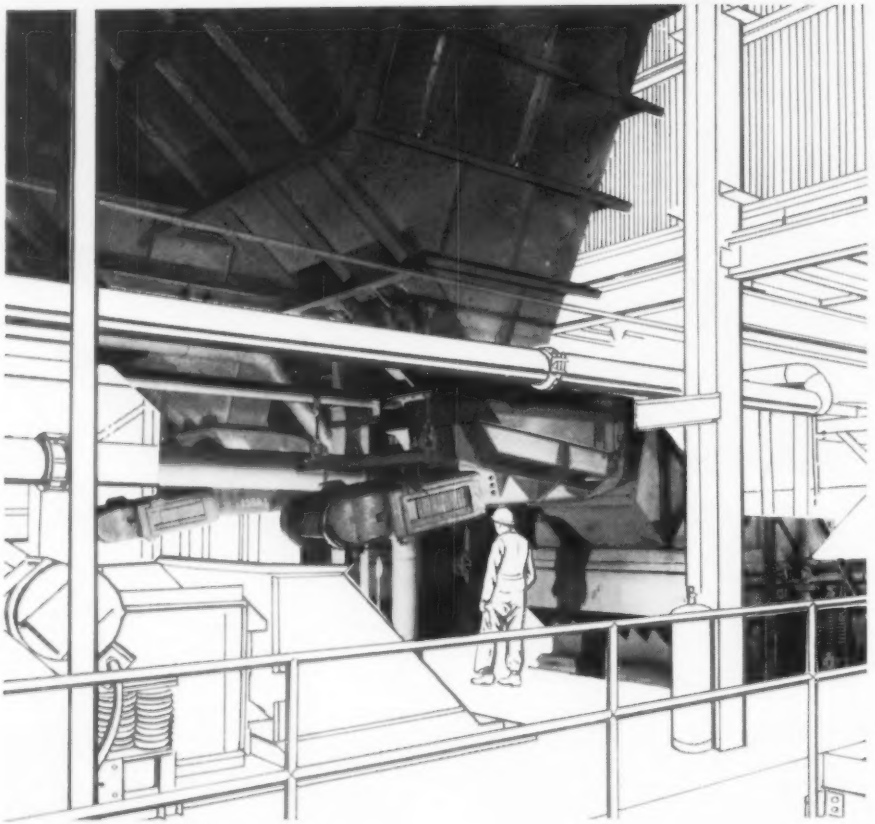
SHOVEL-BASE REDUCER WITH RIGHT ANGLE HEAD



STRAITLINE SPEED REDUCER

SYNTRON cost-cutting equipment of proven dependable Quality

reduces material handling cost



SYNTRON Vibra-Flow VIBRATORY FEEDERS

. . . help reduce production costs.

First, by more efficient material handling. They provide a smooth flow of bulk materials—hot or cold, damp or dry, fine flue dust to big chunks—to processing operations.

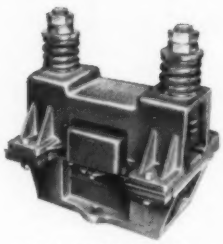
Second, by the instant finger-tip controllability of these feeders. Flow of material can be regulated to match the capacity of operations.

Third, by simplicity of design. The powerful electro-magnetic drive assures long, trouble-free service with very low maintenance cost.

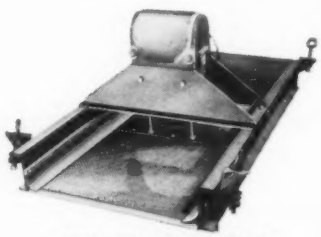
SYNTRON Vibratory Feeders are available in a wide range of sizes and trough styles to meet all your bulk material needs.

. . . write for informative literature today

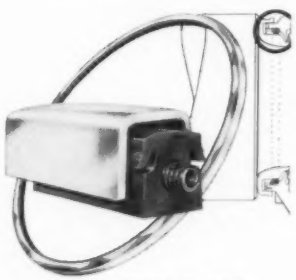
Other SYNTRON Equipment of proven dependable Quality



BIN VIBRATORS



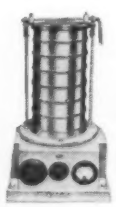
VIBRATING SCREENS



ROLL NECK SEALS

RECTIFIER POWER UNITS

TEST SIEVE SHAKERS



SYNTRON COMPANY

699 Lexington Ave. *Quality Equipment Since 1921* Homer City, Penna.

ALLIS-CHALMERS

A-1235

ACID AREA APPLICATION. Safety equipment and clothing are a "must" for personnel in the acid atmosphere of Dow's chlorine plant at Freeport, Texas. This **Super-Seal** motor came prepared, too — with **Poxeal** insulation guarding the stator.

Nothing...but nothing...stops Super-Seal motors

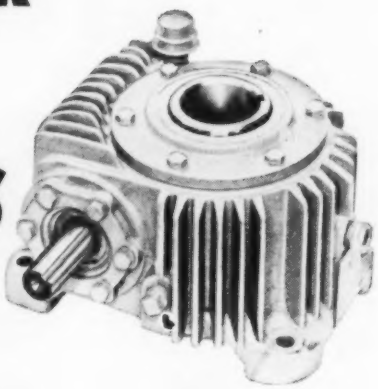
In a tough acid pump installation, Dow Chemical's Texas Division experienced no end of motor troubles. It seemed nothing could stand up in that humid, corrosive atmosphere. Reports Dow: "Even with totally enclosed motors, winding failures were frequent." And, they might have added, expensive.

Then came *Super-Seal* motors— with amazing *Poxeal* insulation. A durable case of epoxy-resin encloses the winding end turns and slot portions of the stator . . . the most complete protection ever developed. Result? The *Super-Seal* motor, *after two years* of continuous operation in the acid area, is as good as ever. So good, in fact, that Dow has ordered 150 *Super-Seal* motors for a new chemical plant at Freeport, Texas.

Isn't it time to revaluate *your* motor standards? There's a good chance that *Super-Seal* motors can solve your motor problems, too. Contact your A-C representative or distributor, or write **Allis-Chalmers,** General Products Division, Milwaukee 1, Wisconsin.

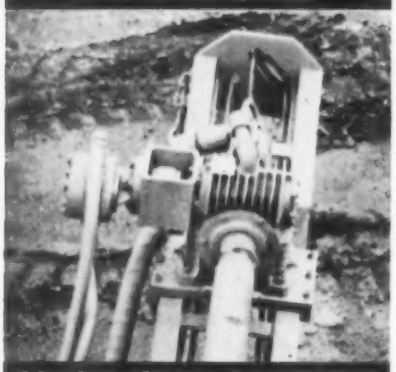
Super-Seal and *Poxeal* are Allis-Chalmers trademarks.

CONE-DRIVE WORM GEAR HOLLOW SHAFT SPEED REDUCERS

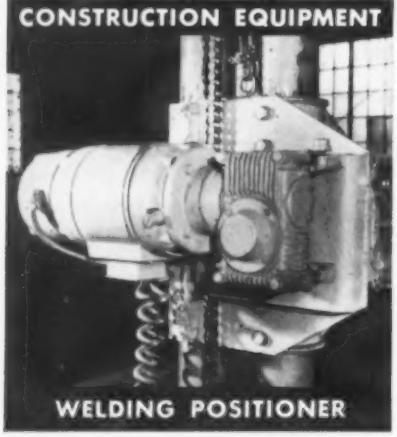


provide greater flexibility in the design of your equipment

MIXING MACHINE



CONSTRUCTION EQUIPMENT



WELDING POSITIONER

Standard Cone-Drive hollow shaft speed reducers are available in four basic sizes (2, 2½, 3 and 3½ inch center distance units) to accommodate loads from fractional to 13 horsepower. They are built around the double-enveloping worm gear design and carry the same high ratings as standard Cone-Drive speed reducers.

You, as a designer, will be particularly interested in the versatility of application and space savings made possible by the right angle design between input and output shafts.

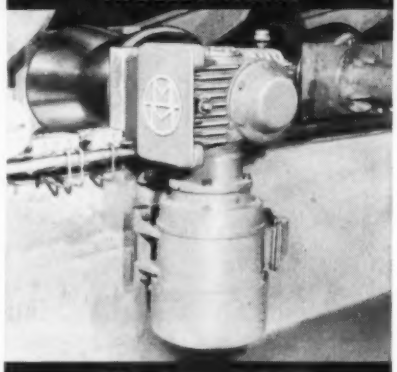
The reducer is mounted directly on the driven shaft and requires only a simple bracket or torque arm to prevent it from rotating about the driven shaft.

Construction is rugged enough to permit floor or wall mounting of Cone-Drive hollow shaft reducers and "hanging" the driven shaft on it (in certain applications), eliminating pillow blocks or bearings. Larger-than-necessary taper roller bearings and heavy-duty castings make this possible.

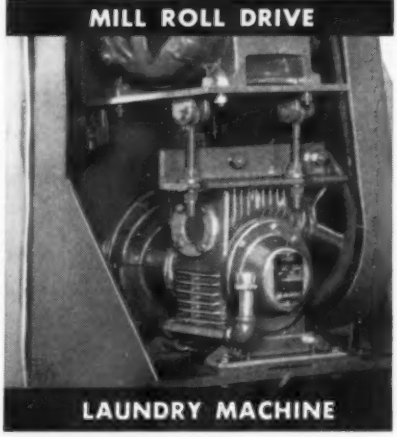
If a motorized reducer is desired, a simple, standard bell housing can be furnished for NEMA C-type face motors. The need for expensive couplings is eliminated since a tang-type drive sleeve and suitably machined worms are provided. When a hollow-shaft speed reducer and face-mounted motor are combined, no bed plate or mounting arrangement is required. Pulleys, belts, sheaves, etc., that might be troublesome or difficult to install are also eliminated.

Ask for Bulletin CD-218.

TROLLEY HOIST



MILL ROLL DRIVE



LAUNDRY MACHINE

CONE-DRIVE GEARS DIVISION MICHIGAN TOOL COMPANY

7171 E. McNichols Road • Detroit 12, Michigan • Telephone: TWinbrook 1-3111

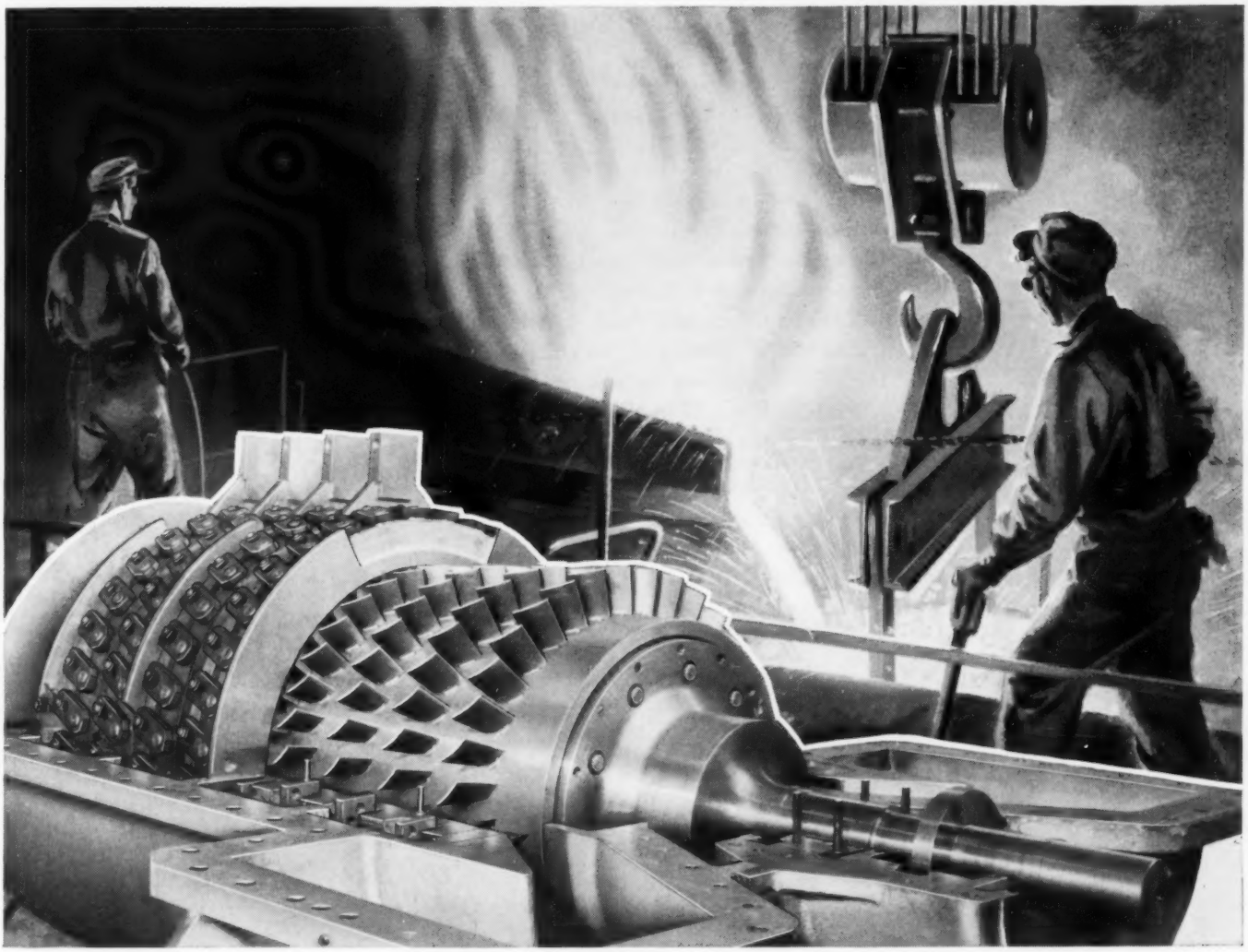
DOUBLE-ENVELOPING WORM GEARSETS

DOUBLE-ENVELOPING WORM GEAR SPEED REDUCERS

DOUBLE REDUCTION WORM GEAR SPEED REDUCERS

DOUBLE-ENVELOPING RIGHT ANGLE GEARMOTORS

ALLIS-CHALMERS

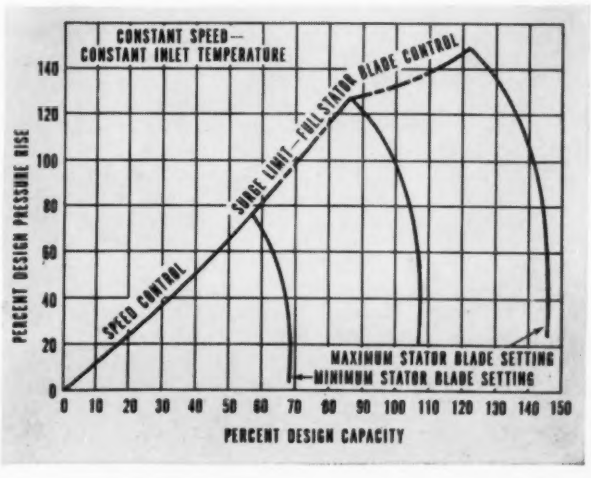


Adjustable stator blade axial compressors from Allis-Chalmers let you

vary wind capacity...cut steam 15%

By simply adjusting stator blades while an Allis-Chalmers axial compressor is operating, capacity can be varied to meet a broad range of operating conditions. A-C axials give high efficiency with practically the same capacity range as centrifugals. Compared to a centrifugal compressor of a similar rating, a 125,000-cfm axial, for example, is *half* the diameter and *one-quarter* the weight! You make substantial savings on reduced handling, foundation and space costs. And operating economies reduce steam requirements as much as 15%. Remember: Allis-Chalmers offers industry's *most complete line of rotating compressors.* You'll get an unbiased compressor recommendation, whether you need single or multi-stage centrifugals, multi-stage axials or sliding vane rotaries.

To see and operate a working adjustable stator blade model, contact your A-C office, or **Allis-Chalmers,** *Industrial Equipment Division, Milwaukee 1, Wisconsin.* A-1259

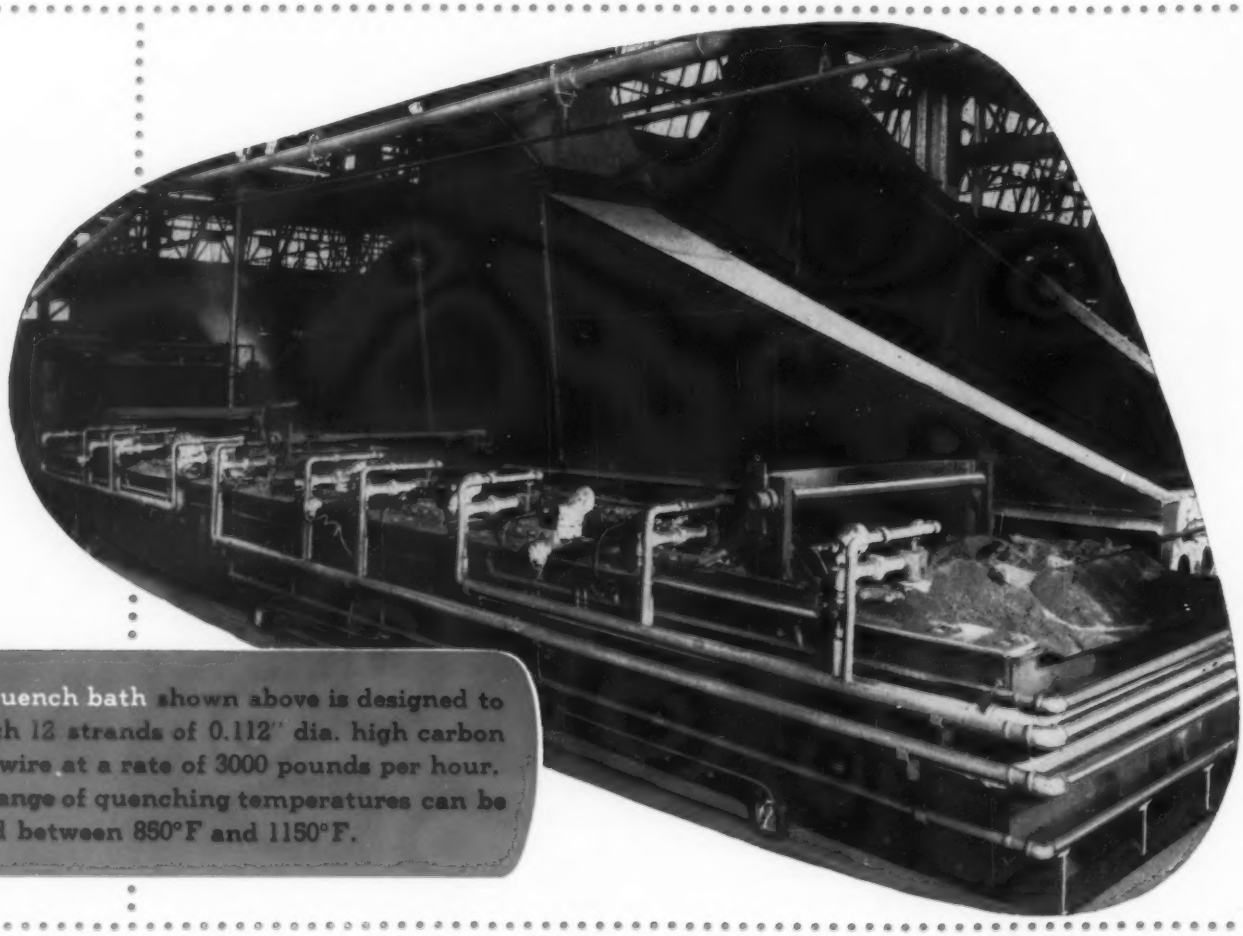


DREVER

IMMERSION TUBE HEATED LEAD QUENCH FOR WIRE PATENTING

This 3-zone 30 ft. long gas-fired immersion tube heated lead quench forms part of a continuous patenting, cleaning and coating line for high carbon steel wires.

The multi-zoned lead quench is not only heated by gas-fired immersion tubes, but also utilizes the same immersion tubes with forced air cooling to maintain uniform temperatures throughout the bath. A specially designed control system automatically proportions the gas heating and/or air cooling of the tubes.



The quench bath shown above is designed to quench 12 strands of 0.112" dia. high carbon steel wire at a rate of 3000 pounds per hour. The range of quenching temperatures can be varied between 850°F and 1150°F.

DREVER COMPANY

RED LION RD. and PHILMONT AVE., BETHAYRES, PA.

32

Engineering and Manufacturing Facilities around the World through Associates in France, Great Britain, Germany, Italy and Japan

Over 8000 Years of Experience

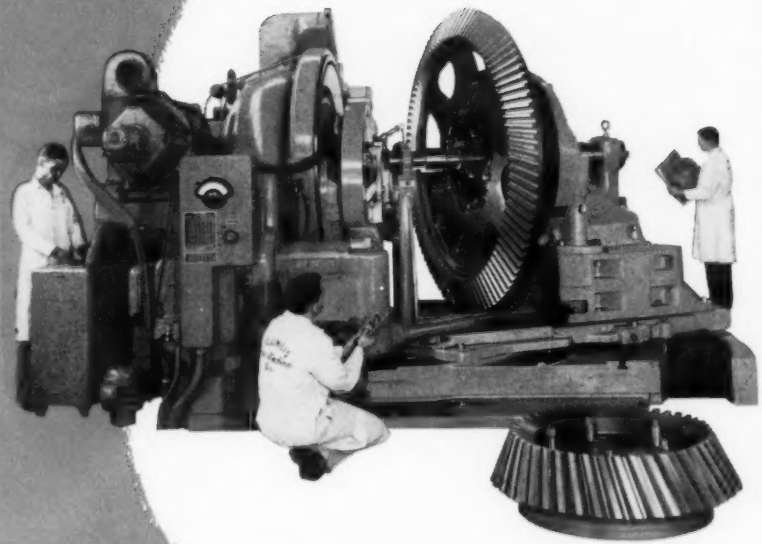
A heritage that safeguards every order for

ILLINOIS GEARS

To every order for ILLINOIS GEARS is added the traditional extra values that are made possible by the rich heritage of manufacturing experience, quality control and . . . very important . . . painstaking careful consideration in following every order through to the very last specification.

All of the hundreds of employees of ILLINOIS GEAR are dedicated to serve you. In all they aggregate a total of over 8000 years in the production of quality gears. Almost half of them have served between 10 and 25 years. Pride in a job well done is paramount with these craftsmen, many of whom are father and son teams.

Profit from this background of experience — depend on ILLINOIS GEAR for your requirements. Write for full information today.



Look for this mark ILG® *. . . the symbol on finer gears*

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Gears for Every Purpose ... one gear or 10,000 or more

ILLINOIS GEAR & MACHINE COMPANY

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DODGE HAS MORE PROVED BEARINGS THAN YOU HAVE BEARING PROBLEMS!

It pays to buy from a line of stock bearings—bearings that have been proved in thousands of installations similar to yours. You benefit by getting known dependability; and you get the important savings of high quality at production price.

PIN-POINT SELECTIVITY

Dodge has supplied mounted bearings to industry for over three-quarters of a century. Dodge bearings have always kept pace with improved production practices. Each new condition of service has been met by Dodge as it has arisen, with the result that the Dodge line contains mounted bearings to meet almost every service requirement with pin-point accuracy.

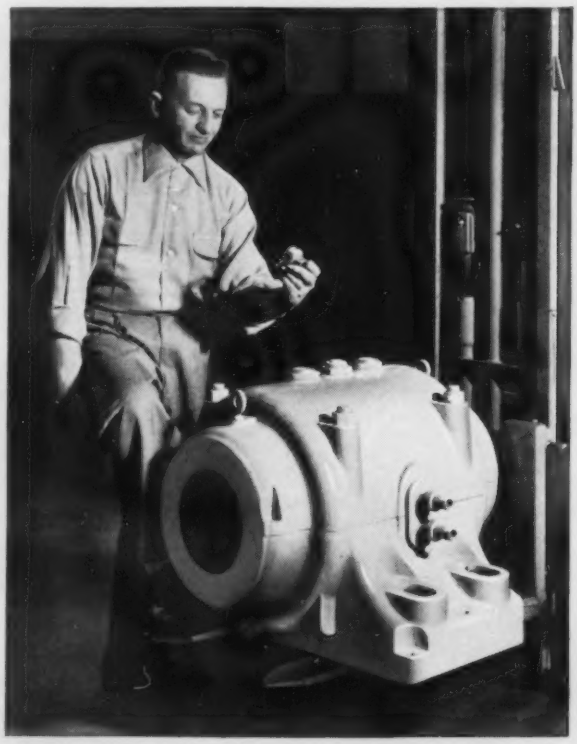
High load, high speed, excessive dust, moisture, corrosion, high or low temperatures, continuous operation—you name it!—such conditions and their combinations are met every day with Dodge bearings.

BROAD LINE—WIDELY DISTRIBUTED

In the great variety of mounted bearings developed by Dodge, you will most likely find the precise unit to fit your requirements ideally—without paying for features you do not need. And if your requirements call for several types of bearings, there is an advantage in having them of common design, such as Dodge offers.

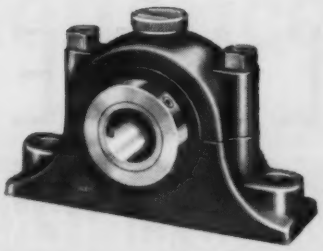
The Dodge line is probably broader than any other line of mounted bearings in America. And of special importance to machinery manufacturers, it is the most widely distributed line. There is always a Dodge bearing of the right type and size near at hand.

You can check this with your local Dodge Distributor. Ask him—or write us for the Dodge Bearing Bulletin.

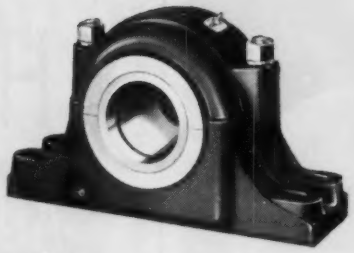


In addition to tapered roller, spherical roller and ball bearings, Dodge builds many types of sleeve bearings. Here is the "large and small" of the sleeve type bearings carried in stock—ranging from an 8-in. Sleevoil weighing over 1200 lbs. to a ½-in. solid journal bearing weighing 9 ounces.

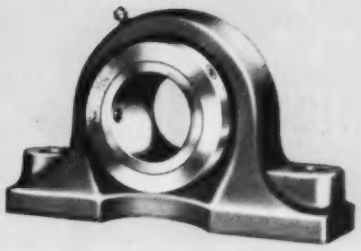
DODGE MANUFACTURING CORPORATION, 5900 Union Street, Mishawaka, Indiana



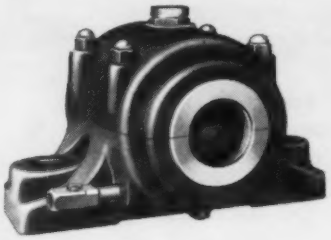
DODGE PILLOW BLOCKS WITH TIMKEN TAPERED ROLLER BEARINGS



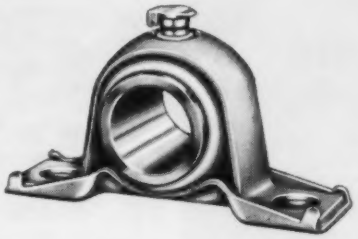
DODGE SPHER-ALIGN PILLOW BLOCKS WITH SPHERICAL ROLLER BEARINGS



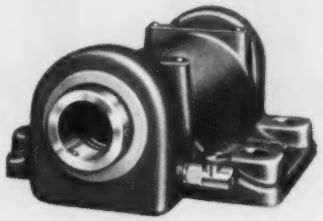
DODGE BALL BEARING PILLOW BLOCKS



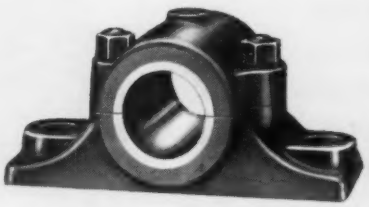
DODGE SLEEVOIL PILLOW BLOCKS



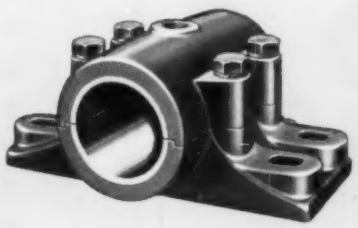
DODGE BRONZOIL PILLOW BLOCKS



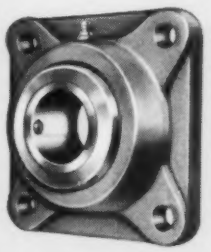
DODGE BRONZE BUSHED PILLOW BLOCKS



DODGE JOURNAL BEARINGS SOLID AND SPLIT



DODGE HEAVY RIGID PILLOW BLOCKS



FLANGE BEARINGS: HANGER BEARINGS: BEARING UNITS: TAKE-UPS

● **Dodge Pillow Blocks with Timken Tapered Roller Bearings.** America's quality pillow blocks. Assembled, lubricated, adjusted and sealed at the factory. 5 types for varying needs.

● **Dodge Spher-Align with Spherical Roller Bearings.** Rugged heavy duty, compact, inherently self-aligning. Exclusive Micro-Mount simplifies installation.

● **Dodge Ball Bearing Pillow Blocks.** Deep groove ball bearings with long inner races—high capacity. SL, SC and SCM models for light, normal and medium service respectively.

● **Dodge Sleevoil Pillow Blocks.** Ultra quality . . . extra long life . . . accessibility . . . *quiet*. Plain or water-cooled.

● **Dodge Bronzoil Pillow Blocks.** Efficient, low cost pillow blocks with self-oiling, capillary bronze bushings. Self-aligning. Large oil reservoirs.

● **Dodge Bronze Bushed Pillow Blocks.** Quiet fan and blower pillow blocks with two bronze bushings of high lead content mounted in one cast iron housing.

● **Dodge Journal Bearings — Solid and Split.** True running, dependable. Babbitted bearings with precision machined bores and faces. Finished bases.

● **Dodge Heavy Rigid Pillow Blocks.** Rugged, carefully bored, babbitted pillow blocks for many applications requiring grease lubrication. Finished bases and ends.

● **Bearing Units.** A wide variety—spherical seat, cartridge, flange, hanger, screw conveyor hanger, take-up. Ball, Roller and Sleeve types.

CALL THE TRANSMISSIONEER—your local Dodge Distributor. Factory trained by Dodge, he can give you valuable help on new, cost-saving methods. Look under "Dodge Transmissioneer" in the *white* pages of your telephone directory, or in the yellow pages under "Power Transmission Machinery."

DODGE

of Mishawaka, Ind.

SPRAYING SYSTEMS CO.

DESCALING NOZZLES

in hardened stainless steel

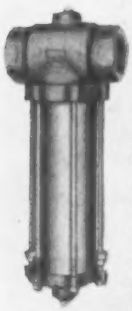
compact
modern design . . . only ½ to ⅓ the size of old nozzle types

advanced hydraulic design
gives extremely sharp, hard hitting FLAT SPRAY pattern

in stainless steel with tungsten carbide orifice tips

large open orifice
keeps clogging to a minimum

Here are spray nozzles with sharp, high-impact flat spray patterns to materially improve your descaling operations. They're small in size for easier installation and better performance. The unusually large orifices go far in solving clogging problems. Made in all capacities in hardened stainless steel for high resistance to sand and silt. And for maximum possible abrasion resistance, they're also made with Tungsten Carbide orifice inserts. Just write . . . we'll be happy to send you complete Descaling Spray Nozzle information.



HEAVY DUTY LINE STRAINERS

Spraying Systems now offers line strainers in a full range of sizes . . . with threaded connections up to 4" N.P.T. size . . . and flanged connections in 3", 4" and 6" pipe size. Designed for operation at pressures up to 125 psi. Unusually large screen areas for high volume capacity. Heavy duty, reinforced screens. Easily flush-cleaned through bottom plug or drain cock. Write for Bulletin 94.

SPRAYING SYSTEMS CO.
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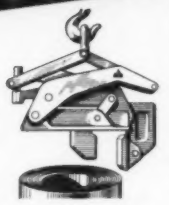
HILL ACME

AUTOMATIC LIFTERS

We are offering a complete line of standard and special lifters from improved designs, resulting in a 50% increase in storage efficiency in many cases.

HILL ACME Automatic Lifters are made of alloy steels with accompanying weight reduction and increased safety factors. They are built to machine tool tolerances by a 75 year old company with an enviable reputation in the field of metals.



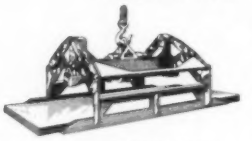
Vertical Coil Lifter

Ingot and standard lifters to meet your requirements

We Welcome Your Inquiries on:

- Coil Lifters
- "C" Hooks
- Rack Lifters
- Billet Lifters
- Sheet Lifters
- Plate Lifters
- Bar Lifters
- Ingot and Ingot Mould Lifters

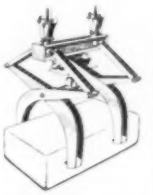
Bar tongs — single or spreader to specifications



Sheet Lifters — Mechanical and motorized styles for handling flat sheets and plate

Also manufacturers of: HILL Surface Grinders, Polishing Machines, Bar-Billet Shears, Alligator Shears, Rotary Scrap Shears, ACME Forging Machines, Tapping Machines, HILLCO Chasers, CLEVELAND Knives and Shear Blades.

"C" Hook, single or multiple, for horizontal coil lifting



Slab Lifter — Motorized mill type

THE HILL ACME COMPANY
MATERIAL HANDLING DIVISION
1201 WEST 65TH STREET
CLEVELAND 2, OHIO

Reliance Super 'T' V★S Drives

Both of these control units are rated at 50 horsepower! Actually, the new, small Super 'T' V★S cabinet packs more punch!

LIKE the Reliance Super 'T' Drive Motor, new V★S power units utilize Class B insulation, permitting a more compact unit. 100% overloads of one minute duration are accomplished without failure! Advanced design of ventilation keeps control and power units cooler . . . another reason why smaller size is possible. And service life is substantially extended.

Matched system design of drive motor, power unit and controls produces a highly efficient, integrated drive—to give you a wide range of stepless, variable operating speeds from a-c. circuits.

Super 'T' V★S Drives are available for immediate delivery. Check your Reliance salesman for delivery schedules on the full line, 1—350 hp., Bulletin Number D-2506, has been prepared to give you complete information. Write for it. D-1641

Product of the combined resources of Reliance Electric and Engineering Company and its Master and Reeves Divisions

RELIANCE ELECTRIC AND ENGINEERING CO.

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Duty Master A-c. Motors, Master Gearmotors, Reeves Drives, V★S Drives, Super 'T' D-c. Motors, Generators, Controls and Engineered Drive Systems.

HAGAN NEWSLETTER — MARCH

Behind the panel

HOW TO CONTROL 42 SOAKING PITS FROM A 50-FOOT CONTROL HOUSE

A major steel producer engaged in an expansion program projected the building of 42 new soaking pits, arranged in 14 rows of 3 pits each, but the space available for a centralized control house was only 50 feet long. This problem was presented to Hagan, along with certain considerations that had to be observed. These were--the panel must provide high visibility of pit temperatures, heaters wanted to be able to see the entire trend of the heat on recorder charts, metallurgists wanted daily access to individual pit temperature and fuel flow records, the instrument department wanted chart changing held to a minimum. Hagan's solution satisfied these seemingly irreconcilable requirements. Here is how it was done: A new Hagan instrument that includes a highly readable pit temperature indicator, plus a 24-hour chart which records pit temperature and fuel flow, satisfied both heater and metallurgist, without the necessity of withdrawing the instrument chassis from its protective case. All row variables--flue pressure, air pressure, combustion air temperature and recuperator temperature--are recorded on miniature 30-day strip charts. The panel width for one row is exactly 42 inches so that the total width for the 42 pits will be 49 feet, well within the specifications. (Details on request. Ask for Item M-1)

HAGAN SYSTEM KEEPS AUTO TIRES AT pH 6.8

At one stage in the curing of tire rubber, it flows through huge tuber tanks where water must be maintained exactly at a pH of 6.8. This part of the process insures the elimination of hairline cracks in tires after weathering. The Hagan system constantly measures water flow into the tanks and, at the same time, the pH of the water. These two signals are combined to adjust the stroke of an acid feed pump which injects an accurately measured amount of acid into the main water system. The two measurements are made so accurately that the pH of the water has been maintained at exactly 6.8 despite widely varying flows. (Details on request. Ask for Item M-2)

BAKING OVEN FOR MISSILE WINGS CONTROLLED BY HAGAN

Missile wings made of honeycomb aluminum covered with a plastic resin must be cured in an oven that not only bonds the plastic to the aluminum core, but also assures a smooth and hard surface resistant to air erosion. The control system programmer establishes the desired temperature and duration of the curing process. Temperatures are slowly elevated and then reduced over a 12 to 24 hour period. A Hagan GT thermostat senses the temperature in the oven and sends a signal to a Hagan Ratio Totalizer. Any error between transmitted temperature and set point brings about the regulation of a blending damper controlling the amount of ambient air blended with electrically heated air. Engineers like the system because of its simplicity and the ease with which programs can be changed to meet new conditions. After two years of operation, the system has proved extremely accurate, and maintenance has been only routine. (Details on request. Ask for Item M-3)

BASIC OXYGEN STEEL PROCESS CONVEYORS GO PNEUMATIC

Among the steel companies who are making use of the new basic oxygen process, one has come to the conclusion that the best way to convey burnt lime and limestone to the vessel is pneumatically. And, to make sure that the system works accurately and with the least possible maintenance, the control system should also be pneumatic. On this particular system, Hagan controls the flow of material from the track hopper to the holding bin to the batch hopper. At each point, interlocking controls assure that the flow of material will be uninterrupted and will arrive at the vessel in the exact quantities demanded by the operator. In operation for over two years, the system has proved efficient and dependable and has required only routine maintenance. (Details on request. Ask for Item M-4)

HAGAN CHEMICALS & CONTROLS, INC., Hagan Building, Room 711, Pittsburgh 30, Pa.

HAGAN DIVISIONS: CALGON CO. — HALL LABORATORIES — BRUNER CORP.

Foreign Digests

Complete translations from which these condensations were prepared are available from Henry Brutcher, P.O. Box 157, Altadena, Calif., to whom all correspondence should be addressed.

"BEHAVIOR OF IRON ORES DURING SINTERING" PART I

by W. VOR DEM ESCHE and O. STEINHAUER, Metallurgical Department, Westfalenhütte A.G., Dortmund. (Translation No. 4697 from Archiv Eisenhuttenwesen, Vol. 30, 1959, No. 4)

Δ THE production of blast-furnace sinter for basic bessemer iron and its characteristics have been under systematic study at the firm of Hoesch-Westfalenhütte in Dortmund since 1953. When higher percentages of sinter were used in the burden, difficulty had been encountered in obtaining proper gas flow in the furnace, and this led first to an examination of the softening behavior of the sinter. It was found that the softening temperature range of sinter is very narrow when the composition of the slag-building agents, i.e., the percentages of lime, silica and alumina, lie near the ternary eutectic at 2310 F in the lime-silica-alumina system. A sinter of this type has the further advantage that the composition of the gangue resembles that of blast furnace slag, thus transferring part of the slag-forming work from blast furnace to the sintering machine where it is effected with coke breeze instead of blast furnace coke.

Further investigations on the production of this type of sinter showed that there was no drop in output of the sinter plant with lime-silica ratios as high as unity. In these trials the lime was added to the sinter in the form of ore with excess lime, or as limestone sand. The particle size should not exceed No. 6-7 U. S. mesh to prevent the appearance of free lime in the sinter. By more intense slagging and raising the iron content to about 50 per cent, it was possible to obtain a sinter of sufficient strength which also showed stability during storage.

The development of a method for determining the sinter-formation temperature of iron ores based on examination of the structure of the material is described. In this "interrupted sintering" method, compacts of fine ores are heated to certain temperatures and then examined in polished sections for changes in their structure. The temperature rise during the heating of the specimens and the degree of oxidation of these specimens correspond to conditions prevailing in continuous production sintering.

The experimental results are described, using the magmatic Kiruna ores and the sedimentary Salzgitter ores as examples. The sintering process involves considerable fusion of the ore and formation of new crystals through recrystallization and primary crystallization. The gangue is transformed to glass with a certain iron content, which can itself be transformed to fayalite by annealing. In sinters made from lime-containing ores, the presence of calcium ferrites was also established.

When the gangue consists mainly of silica, the sinter-formation temperature of the ore is determined primarily by the amount of slag-building components. With an increasing proportion of slag, this sinter temperature drops from 2840 F to about 2550 F. In the case of ores with increased lime contents, the formation of low-melting calcium silicates or calcium ferrites leads to a considerable drop in the sinter formation temperature, down to 2230–2280 F.

Reduction experiments with hydrogen showed that, as the formation of slag increases, the magnetite grains are blocked off from the action of the reducing gas.

OTHER AVAILABLE TRANSLATIONS

"Ladle Desulphurization of Iron with Lime and Aluminum Suspended in a Gas," by S. K. Sobolev and G. N. Oiks. Izv. VUZ, Chern. Met., Nov. 1958. Earlier work on removal of sulphur from liquid pig iron outside of the blast furnace. Development of pilot-scale equipment for desulphurizing hot metal with lime and aluminum suspended in air or nitrogen. Design of grinder unit, etc.; screen analysis of lime used; setup for blowing. Thermodynamic analysis of desulphurizing treatment proposed. Degree of sulphur removal attained; data on consumption of lime and aluminum. Advantages of blowing the hot metal in ladle while the latter is being filled. Variation of silicon and manganese contents of iron during blowing. Nature of effect of the aluminum added. (Translation No. 4623)

View of mill housings in process of re-machining

Better than New!

This Five Stand Tandem Hot Finishing Mill has been in use for many years in the Pittsburgh Area. It is being completely modernized with the latest design features including automatic screwdown, improved anti-friction roll neck bearings, etc. Then the original mill, in better than new condition since equipped with these modern features, will be operated in the Chicago District for many future years of competitive service in the steel industry.

As Builders of Rolling Mill Equipment, we will be pleased to quote on your requirements for re-built or new installations.

"Electric and open hearth steel castings from 1 lb. to 100 tons"

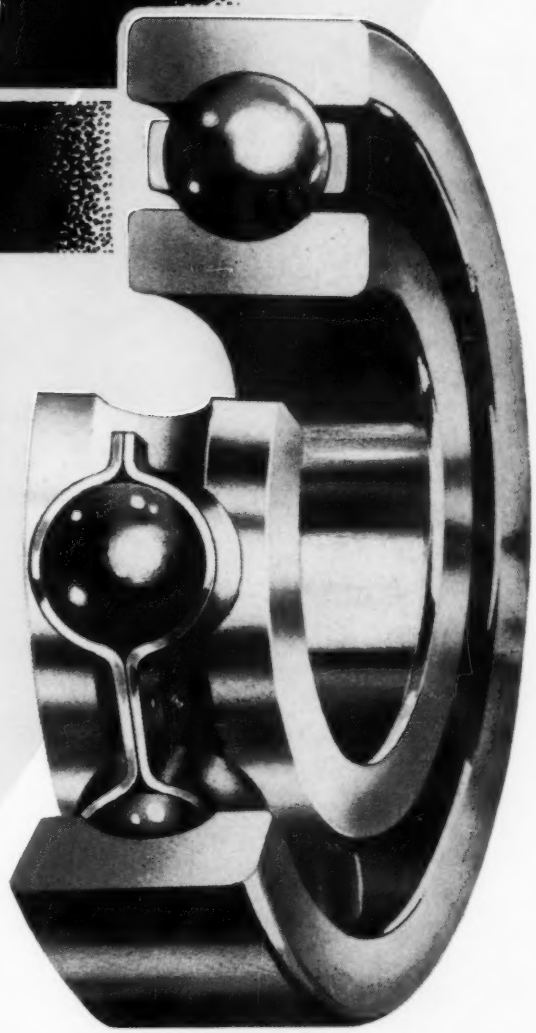
HEAVY MACHINING FACILITIES

Our plant is equipped with a superior complement of well diversified machine tools that are available on a continuing basis for economical machining of heavy castings or the manufacture of auxiliary rolling mill equipment, such as heavy mill tables, furnace pushers, slab depilers, downcoilers, ingot buggies, slab transfers, etc.

PITTSBURGH
ENGINEERING & MACHINE DIVISION
Pittsburgh Steel Foundry Company
TEXTRON, INC.

BOX R, GLASSPORT, PA. · PLANTS AT GLASSPORT & McKEESPORT, PA.

40 years of IMMEDIATE DELIVERY



Away back in 1920, when Berry Bearing Company was founded, the new company established a basic policy of *immediate delivery* on *every order*, large or small.

In those days, when a customer phoned a bearing distributor and ordered a bearing, the customary reply was--"Come and get it"--*if* the bearing was in stock, which all too frequently was not the case.

In contrast, Berry startled customers and competition alike by replying--"We've got it...and...we'll make delivery immediately. Obviously, having the bearing in stock and being eager to make immediate delivery on all orders offered bearing users two outstanding advantages which promptly attracted customers and started the new company on its way to success.

For 40 years Berry Bearing Company has maintained its original basic policy of--immediate delivery on every order, large or small. Today, Berry Bearing is one of the largest bearing distributors in the United States...and...is authorized stock-carrying distributor for 41 of the nation's leading manufacturers of bearings, bearing specialties, and transmission appliances.

Thus, with an inventory of over 50,000 items regularly in stock, Berry can supply you with *anything* you need. And, as usual, you'll get immediate delivery on every order, large or small.

MEMBER AFBDA ANTI-FRICTION BEARING DISTRIBUTORS ASSOCIATION

BERRY BEARING COMPANY

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AURORA
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TWin Oaks 7-8552

JOLIET
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JOliet 3-3446

OAK PARK
327 Madison St.
EUclid 6-1700

SKOKIE
4438 Oakton St.
ORchard 4-6600

WAUKEGAN
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Halsted at 12th St.
SKyline 4-6300

DAILY GRIND ALWAYS UNIFORM

with Pennsylvania Reversible Hammermills

Regardless of condition of coal or amount of hammer wear—Pennsylvania Hammermills are noted for producing a highly uniform product day after day.

Basic design and simple adjustments available to the operator on the spot make this possible.

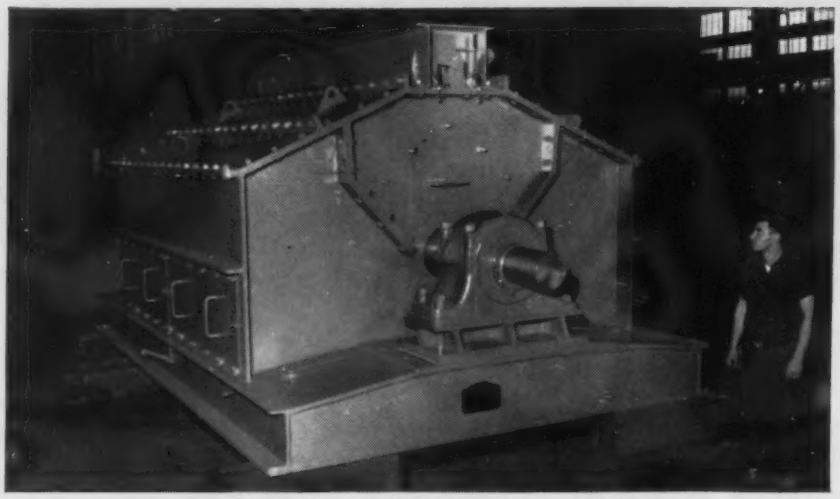
Pin point adjustments of cage-hammer clearance (by ratchet wrench and worm gear assembly) compensate for hammer wear or coal condition.

Crushing action keeps fines to minimum. Free air impact crushing in upper zone prepares coal so there is little dredging of hammers through oversize in cage-bar zone. Results—uniform grinds day after day.

DOUBLE CRUSHING AREA: DOUBLE CAGE, BLOCK AND HAMMER LIFE

No other crushers give you so much more for your money. Pennsylvania Reversible Hammermills give double the crushing area—double the life of cage bars, breaker blocks and hammers. A flick of the switch; rotor is reversed and you are using a duplicate mill.

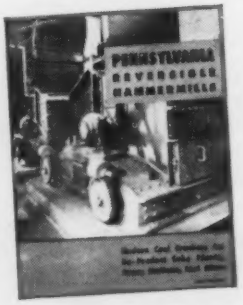
What's more, hammers need never be hand turned, and wear is kept uniform.



● Pennsylvania Reversible Hammermill, typical of type used in by-product coke plants, ready for shipment.

With adjustable cage assemblies, hammers can be worn much further while keeping grind uniform—with no falling off of tonnage.

FREE BULLETIN



Bulletin 1040, giving a full description of the design, construction features, operation and maintenance of Pennsylvania Reversible Hammermills, can prove profitable reading for you. Write for a copy today.

PENNSYLVANIA CRUSHER DIVISION
BATH IRON WORKS CORPORATION
WEST CHESTER, PENNA.

DOUBLE DIVIDEND!

Pennsylvania Bradford Breaker cleans coal as it crushes

Famous Pennsylvania Bradford Breakers not only crush and size run-of-mine coal—they automatically remove and discharge tramp iron and other refuse. This is just one of many features giving Pennsylvania world leadership for this type of crusher. Over 60 million tons of coal annually are prepared by Pennsylvania Bradfords in coke plants everywhere.

For complete information, write and ask for Bulletin 3009.

★ ★ ★

Over 50 years concentrated experience in all types of material reduction makes Pennsylvania your best source of crushers and engineering advice and service. Call on Pennsylvania with your next crushing problem. Representatives from coast-to-coast.

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BATH-BUILT

CRUSHERS

VICTOR R. BROWNING
MILL TYPE CRANES
to Specification..

Basically designed as required by A.I.S.E. specifications, mill type cranes built by Victor R. Browning & Co., Inc. also offer the opportunity of specifying preferences and standards prevailing in the purchaser's plant. May we have your next inquiry?

VICTOR R. BROWNING & COMPANY, Inc.
WILLOUGHBY (CLEVELAND), OHIO
DESIGNERS AND BUILDERS OF ELECTRIC OVERHEAD TRAVELING CRANES AND HOISTS AND ELECTRIC REVOLVING CRANES

CENTRALIZED CONTROL
ROOM FOR TWO BATTERIES
OF BLAST FURNACE GAS
UNDERFIRED COKE OVENS

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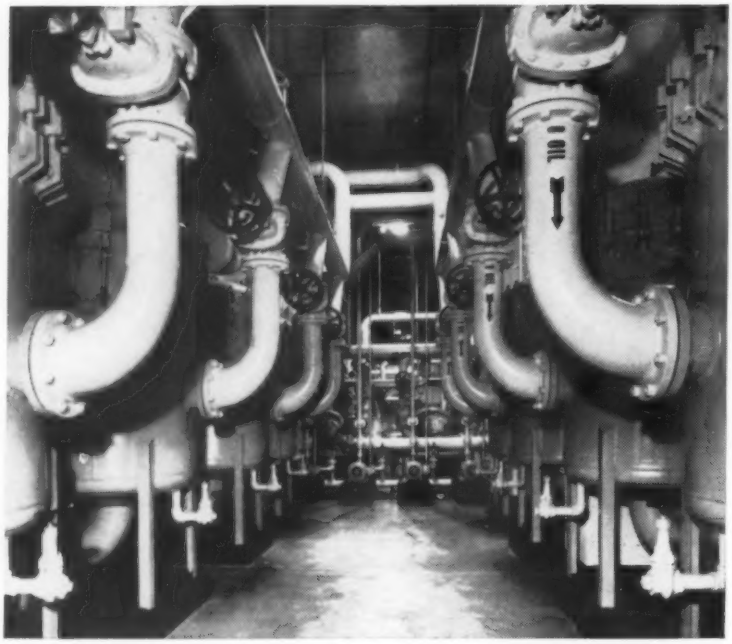
WILPUTTE

COKE OVEN DIVISION
ALLIED CHEMICAL CORPORATION, *40 Rector Street, New York 6, N. Y.*

Dual Dravo-DeLaval coolant systems for new 31-inch cold strip mill



Filtration area contains two banks of full flow filters for cleaning mineral oil and water soluble coolants.

A new Sendzimer cold strip mill, built for the Scovill Manufacturing Company, Waterbury, Conn., which will roll both aluminum and brass, is equipped with a twin, custom-designed Dravo-DeLaval coolant and lubricating system. One system supplies mineral oil when aluminum is being rolled, and the other soluble oil and water for brass.

The dual design permits instant switching of lubricants to match frequent mill changeovers. Coolant is supplied at the rate of 750 gallons per minute at a 350-foot head, and each system includes a 15,000 gallon 3-section reservoir. Dual pumps are provided, one for the coolant system itself, and one for the cooling circuit. Cartridge type, full-flow filters which remove foreign particles as small as 15 microns assure clean oil at the mills.

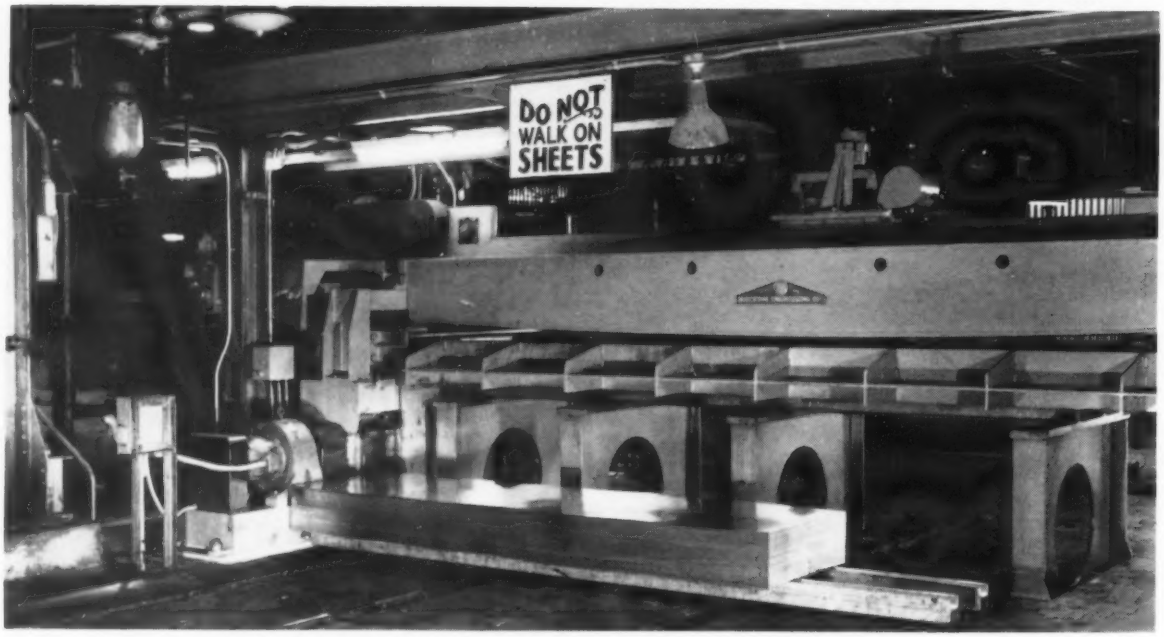
Completely engineered by Dravo, this unusual dual installation was quickly and easily put in service, and required no engineering time at the site. For information on how high efficiency, Dravo-DeLaval oil systems can save you time and money, write Dravo Corporation, Pittsburgh 22, Pennsylvania.

DRAVO
CORPORATION
Dravo-DeLaval
OIL SYSTEMS

DRAVO

Blast furnace blowers • boiler and power plants • bridge sub-structures • cab conditioners • docks and unloaders • dredging • fabricated piping foundations • gantry and floating cranes • gas and oil pumping stations • locks and dams • ore and coal bridges • process equipment • pumphouses and intakes • river sand and gravel • sintering plants • slopes, shafts, tunnels • space heaters • steel grating • towboats, barges, river transportation

THE BUCCICONI MAGNETIC SHEET PILER



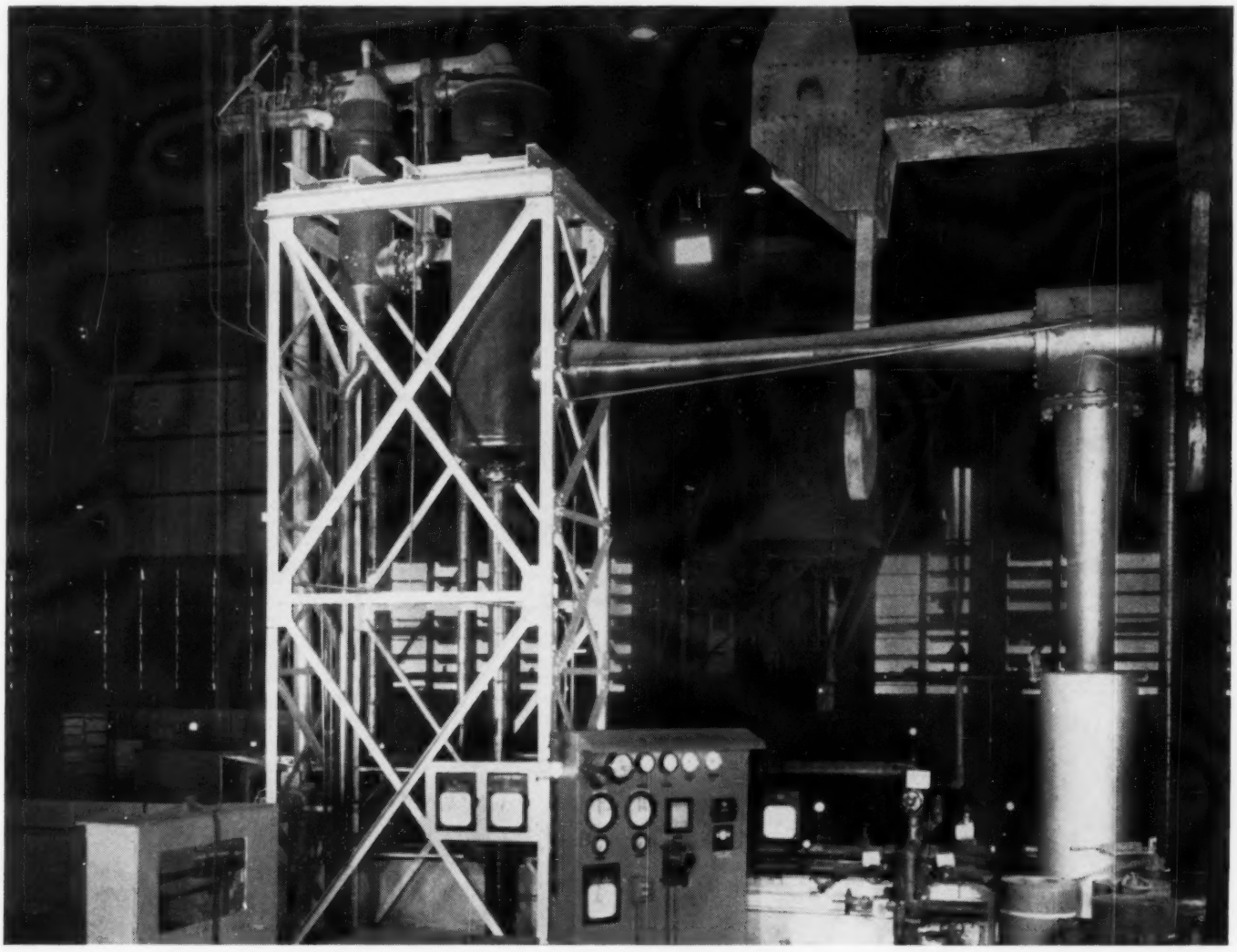
This machine efficiently handles steel sheets up to 60 x 200" at speeds up to 450 fpm with an absolute minimum of surface damage.

BUCCICONI ENGINEERING COMPANY INC.

PIONEERS AND MANUFACTURERS OF MAGNETIC AUTOMATION MACHINERY FOR HANDLING STEEL SHEET AND STRIP
MANUFACTURERS OF MAGNETIC CONVEYERS, MAGNETIC SHEET PILERS AND DE-PILERS, MAGNETIC ROLLS, MAGNETIC PROXIMITY INDUCTO-SWITCH, THE D. B. MICROGAGE, AND TIN PLATE ASSORTING EQUIPMENT.

899 GRANT STREET GARY, INDIANA, U. S. A.

In this 36-in. four-stage Elliott steam jet ejector, the first stage at lower right points vertically upward, second stage in center points horizontally to the left. Third and fourth stages are at upper left, instrument panel is on lower center.



today **ALL** production-size vacuum casting operations employ **ELLIOTT EJECTORS**

THE BIG BREAK-THROUGH in the degassing of steel is made possible by Elliott multistage steam jet ejectors. While high-grade steel forging ingots (up to 250 tons) are being poured, Elliott ejectors are removing unwanted gases, efficiently and economically. Results are stronger, more uniform forgings, improved ductility, and reduced flaking and embrittlement.

Elliott steam jet ejectors are currently in use or on order for *all of the vacuum casting installations of production size* throughout the country. One example of several applications already in operation is the United States Steel Corporation installation seen above, a 36-in. four-stage steam jet pumping unit. Others include a 24-in. six-stage steam jet ejector which serves a consumable electrode vacuum melting furnace, a 36-in. six-stage ejector serving a vacuum heat treating furnace, and two five-stage ejectors serving vacuum induction melting furnaces.

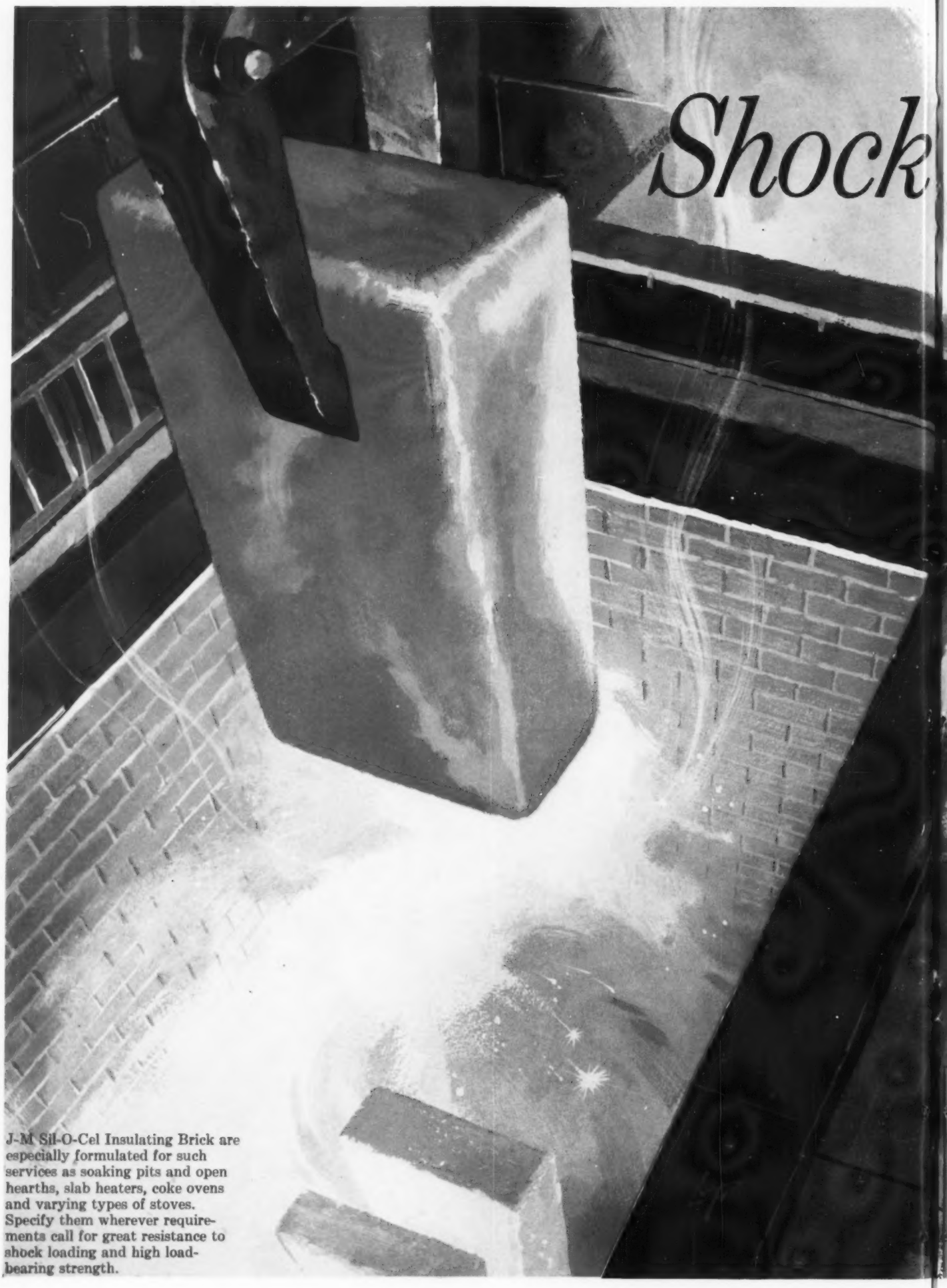
Elliott Steam Jet Ejectors provide these advantages:

SIMPLICITY • ECONOMY

COMPACTNESS • DEPENDABILITY

ELLIOTT Company
JEANNETTE, PA.

G9-2



J-M Sil-O-Cel Insulating Brick are especially formulated for such services as soaking pits and open hearths, slab heaters, coke ovens and varying types of stoves. Specify them wherever requirements call for great resistance to shock loading and high load-bearing strength.

k loads...and crushing weight

call for Johns-Manville Sil-O-Cel Insulating Brick!

Hot blast stove walls, open hearths, soaking pit bottoms—the unexcelled performance of J-M Sil-O-Cel® brick in rugged services like these explains their wide acceptance. Today, they are used as back-up insulation by virtually every major equipment builder.

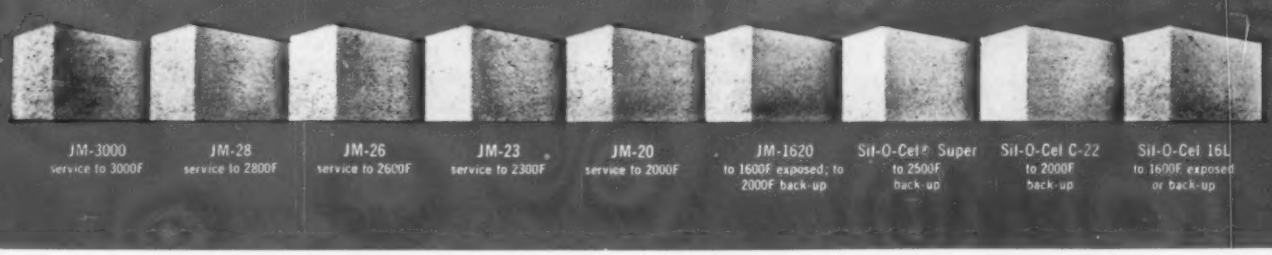
Made of heat-resistant diatomaceous silica, Sil-O-Cel Insulating Brick are produced in three load-bearing types: Sil-O-Cel *Super* (to 2500F) and Sil-O-Cel *C-22* (to 2000F) for peak performance and long life under extremes of heat, weight and shock. Sil-O-Cel *16L* combines performance and economy for lower temperatures to 1600F.

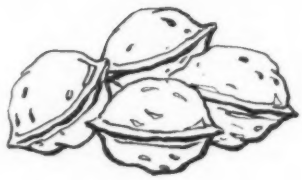
To bring you the right brick for your needs, Johns-Manville *also* offers six Insulating Fire Brick types. This wide selection of Insulating Fire Brick lets you choose the *one* brick that gives you the most favorable combination of temperature resistance, strength, conductivity, density and cost.

Write today for your copy of IN-115A, 8-page booklet on Johns-Manville Insulating Fire Brick. It gives complete physical and thermal properties of each type, along with sizes and shapes available. Address Johns-Manville, Box 14, New York 16, New York. In Canada, Port Credit, Ontario.

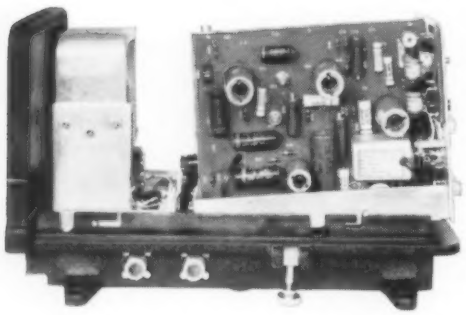
JOHNS-MANVILLE JOHNS-MANVILLE JM PRODUCTS

THE INDUSTRY'S MOST COMPLETE LINE OF INSULATING FIRE BRICK


JM-3000 service to 3000F
JM-28 service to 2800F
JM-26 service to 2600F
JM-23 service to 2300F
JM-20 service to 2000F
JM-1620 to 1600F exposed; to 2000F back-up
Sil-O-Cel® Super to 2500F back-up
Sil-O-Cel C-22 to 2000F back-up
Sil-O-Cel 16L to 1600F exposed or back-up

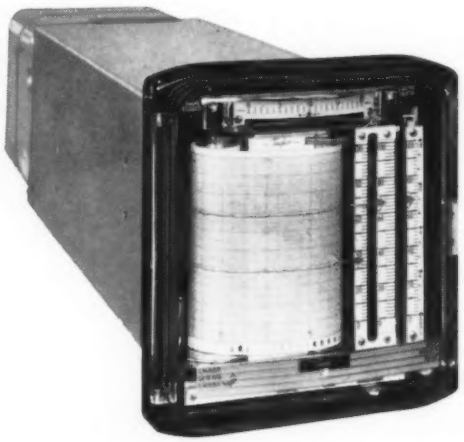
FROM TO 

From simple temperature measurement to a complete Scanning and Logging system . . . you get accurate, dependable instruments when you specify Taylor



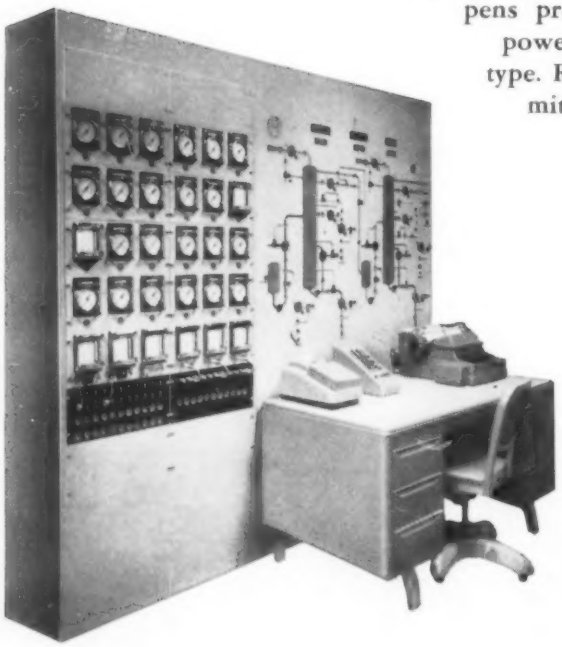
700T Potentiometer Transmitter

Converts a DC primary electrical signal into a 3-15 psi pneumatic output for controllers and receivers. Continuous, electronic standardization eliminates slide wires, batteries and moving parts. Plug-in service "cans" permit instant conversion from one type of service to another. Ask for **Bulletin 98262.**



90J TRANSCOPE* Recorder

Most convenient, most compact recorder yet developed for modern instrument panels. Front-of-panel control settings permit easy adjustment while recording. "Servomatic" power pens provide 150 times more power than bellows-actuated type. Responsiveness to transmitter output is 0.1%. Ask for **Bulletin 98286.**



Taylor TRANS-SCAN-LOG* Control System

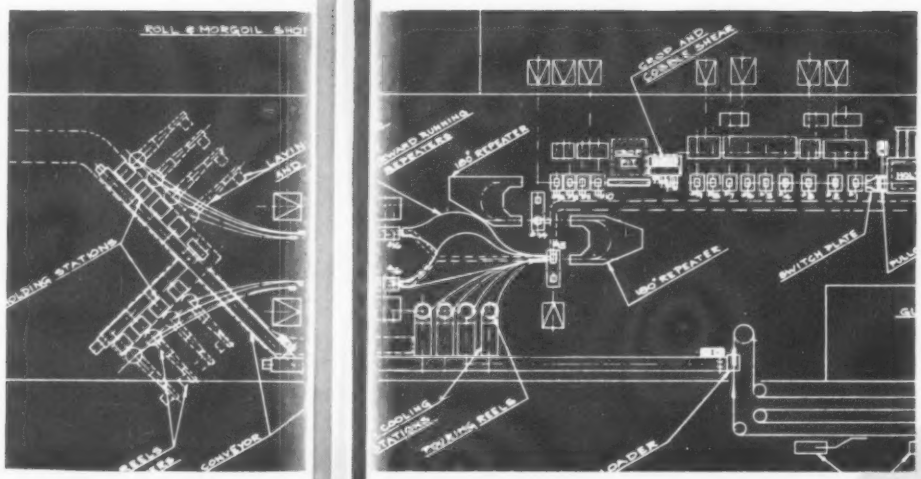
Interlocks scanning and logging with process control, enabling an operator to instantly visualize, evaluate and act upon any processing irregularity as it occurs. Scans and logs up to 650 points of measurement. Proven dependable in over three years of field service, the TSL System meets today's requirements for complete process supervision with minimum manpower. Ask for **Bulletin 98268.**

Call your Taylor Field Engineer or write for Bulletins. Taylor Instrument Companies, Rochester, N.Y., and Toronto, Ontario.

*Reg. U.S. Pat. Off.

Taylor Instruments **MEAN ACCURACY FIRST**

Your Customer's Requirements Draw the Specifications for MORGAN Rolling Mills



Today's market dictates a changing pattern of demand. And every tomorrow presents a challenge. Metals change—uses change—problems of labor change—innovations appear everywhere.

MORGAN utilizes up-to-the-minute creative engineering skills backed by 72 years of accumulated experience in the rolling mill field to make every *new* MORGAN MILL meet the demands of the future.

Each Morgan Mill starts with these basic questions, "What are your customer's requirements and, how can we do the very best job of helping you fill these needs?"

MORGAN WORCESTER

MORGAN CONSTRUCTION COMPANY
WORCESTER, MASSACHUSETTS

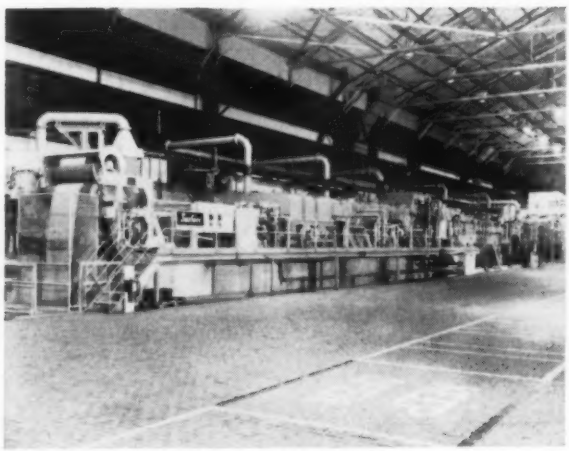
ROLLING MILLS • MORGOIL BEARINGS • GAS PRODUCERS
WIRE MILLS • EJECTORS • REGENERATIVE FURNACE CONTROL

RM-81

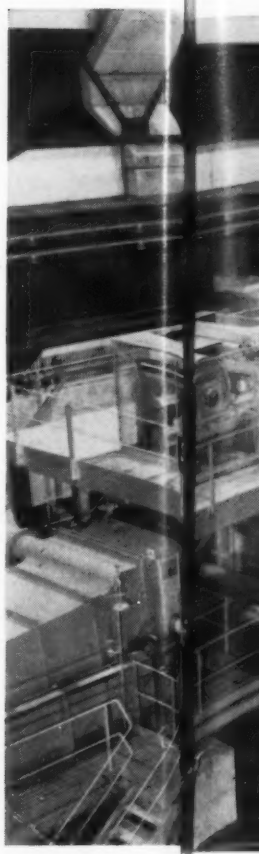
complete normalizing line:

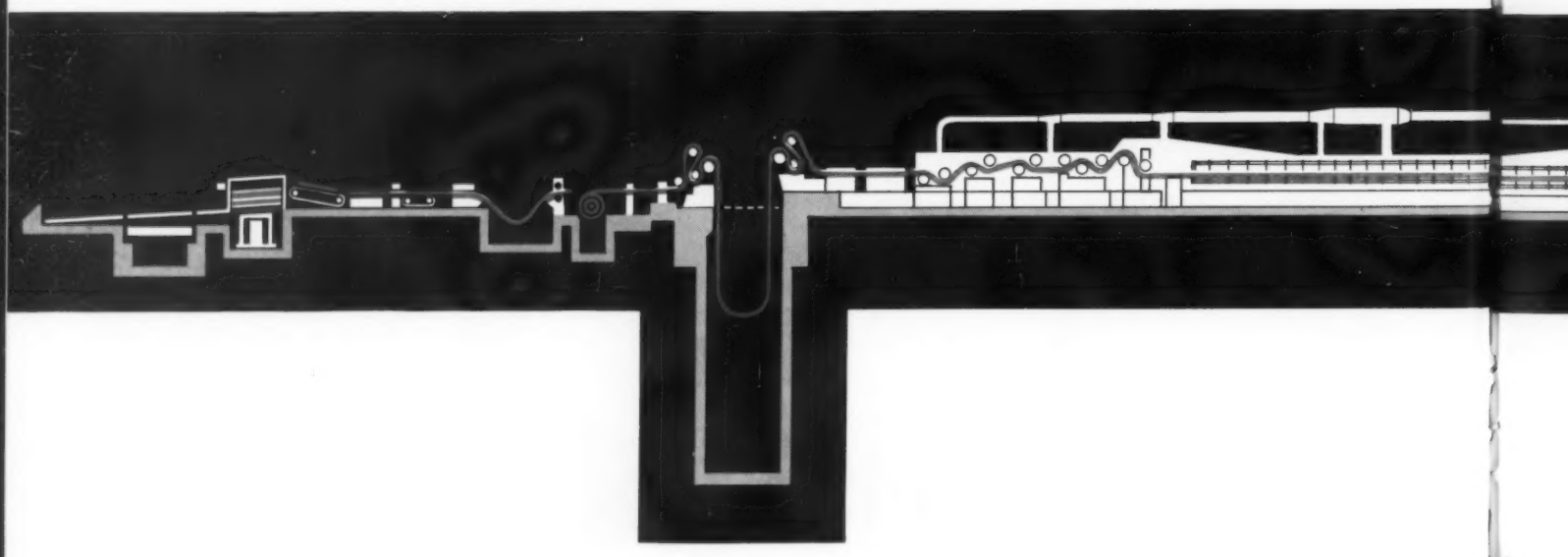
ALL SURFACE!

Exit end of the line, showing looping pit, "re-coiler," automatic shear and sheared sheet piler.



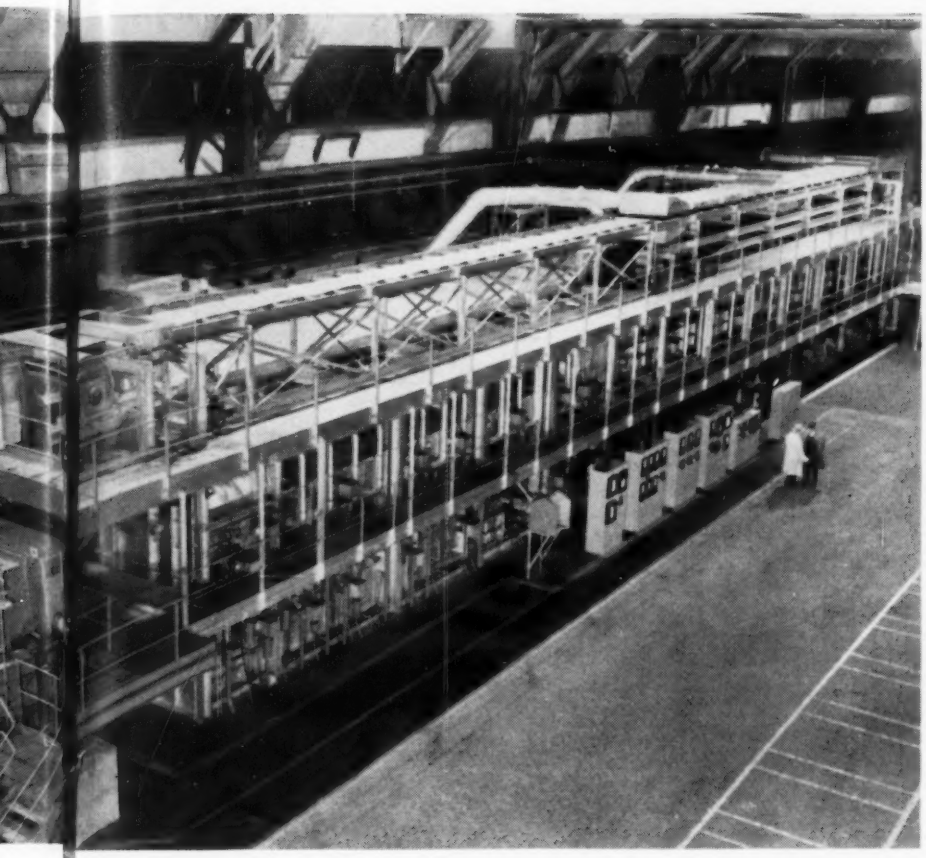
Pickling section includes acid bath, water rinse tank, brush scrubbers, alkali tank and dryer, all installed by Surface. This view shows the exit end of the section.



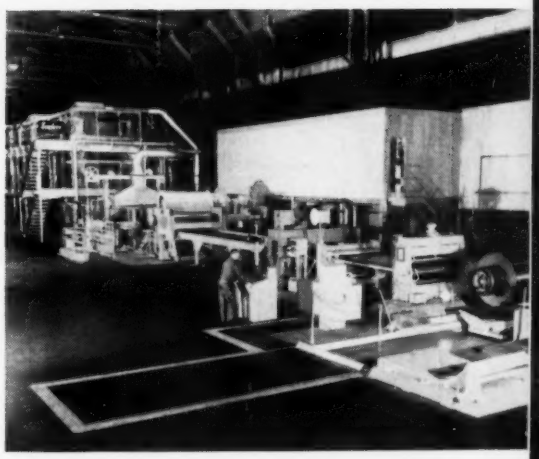


from payoff...to payoff

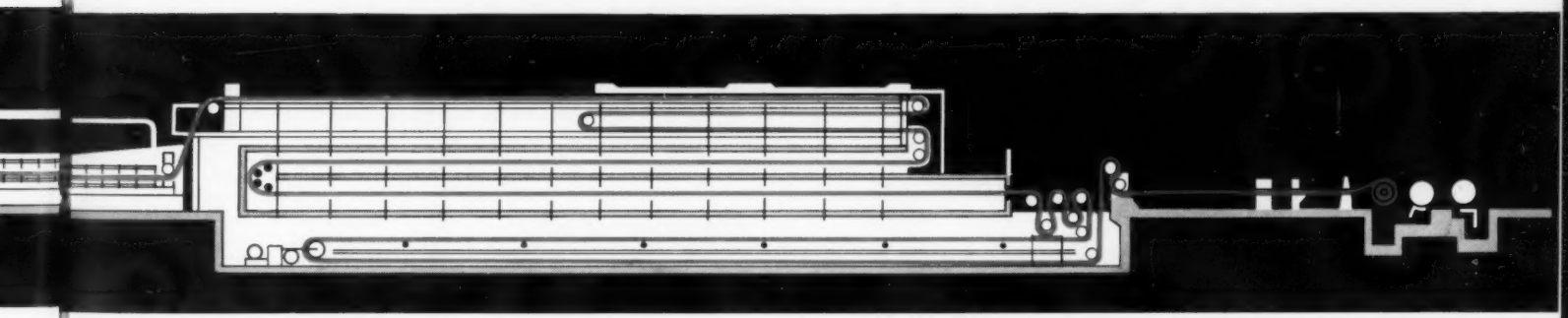
Worldwide engineering and manufacturing facilities through associates in
Australia • Belgium • France • Germany • Great Britain • Italy • Japan



Rockwells in the low 40's are achieved consistently in this three-level normalizing furnace. Heating zone is on the lower furnace level; convection cooling in the middle; air blast cooling at the top. A horizontal "looper" is located underneath the furnace.



Payoff reel marks the entry of low carbon stock after cold rolling. Speeds of 150 fpm on 60" wide strip are attained.



This complete new Surface normalizing line for vitreous enamel stock started paying off on its first day of operation. For example, its capacity of 30,000 lbs. an hour puts this mill forcefully into the market for deep draw quality strip. More than adding new selling power, this big line increased productivity per operator by an almost unbelievable amount.

From payoff reel to real payoff, the entire installation is a graphic demonstration of Surface's qualifications as prime contractor. Applying its global experience in metallurgy, combustion, chemistry, and mechanization, Surface engineered and installed the complete line.

Take the opportunity now to evaluate the prime contracting skills available at Surface, and mobilize them for your profit, ***wherever heat is used in industry.***

Surface

SURFACE COMBUSTION *2404 Dorr Street, Toledo 1, Ohio*

A Division of Midland-Ross Corporation

ACME STEEL
GOES
BUCKEYE
SILICA FIRESTONE

40

YEARS OF SERVICE PROVES
BUCKEYE
LASTS LONGER

THE CLEVELAND QUARRIES COMPANY
AMHERST, OHIO

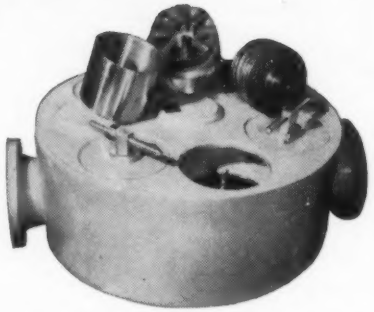
THE WORLD'S LARGEST PRODUCER
OF
SOAKING PIT LININGS

Keep lube oil clean... free from mill scale and other ferrous grit

FERROFILTER®

Magnetic Separators

help reduce gear and bearing wear as well as costly maintenance by extracting even the finest of ferrous particles that bridge the oil film and cause metal-to-metal contact. Sizes range from ⅜" to 8" pipe connections.



Model 6-PA-6 made up of 6 permanent magnet separator assemblies for 8" pipe line.

High Pressure FERROFILTERS up to 5000 psi also available for Hydraulic Systems.

S. G. FRANTZ CO., Inc.
443 Brunswick Pike & Kline Ave.
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MORE QUALITY ENGINEERED FEATURES IN STEPHENS-ADAMSON CARRIERS

Series # 200 Carriers

Series #700 Carrier

35° and 45° Deep Trough Carriers

Pneumatic "Impact" Carriers

ADVANTAGES

- Spun-end roller assemblies and parts interchangeable for quick installation.
- One-Piece, all-steel, welded frame construction.
- Positive lubrication . . . pre-lubricated at factory . . . provisions for field lubrication.
- Roller brackets tilt two degrees in direction of travel for greater belt training effect.
- Die-cast labyrinth bearing seals keep grease in . . . dust and dirt out.

WRITE FOR BULLETIN 355

STANDARD PRODUCTS DIVISION
STEPHENS-ADAMSON MFG. CO.
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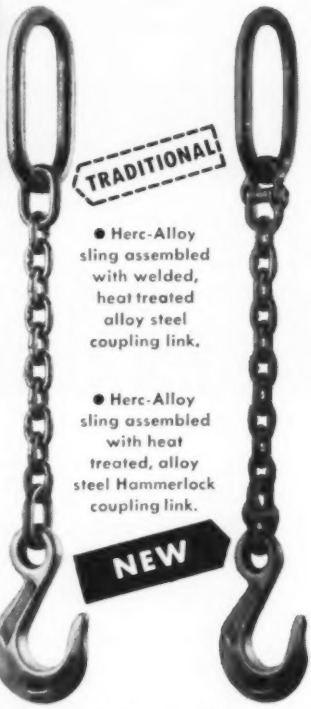
PLANTS LOCATED IN: LOS ANGELES, CALIFORNIA
CLARKSDALE, MISSISSIPPI • BELLEVILLE, ONTARIO

HERC-ALLOY®
...the original alloy steel chain

TO SERVE YOU BETTER:
Herc-Alloy chain assemblies can now be ordered with either of two types of coupling links.

Hammerlok®
the "do-it-yourself" reusable coupling link that enables you to assemble or rebuild your own Herc-Alloy sling chains with all components furnished by your local distributor.



● Herc-Alloy sling assembled with welded, heat treated alloy steel coupling link.

● Herc-Alloy sling assembled with heat treated, alloy steel Hammerlock coupling link.

CALL YOUR CM CHAIN DISTRIBUTOR or write for helpful literature on alloy chain assembly, care, use and inspection.

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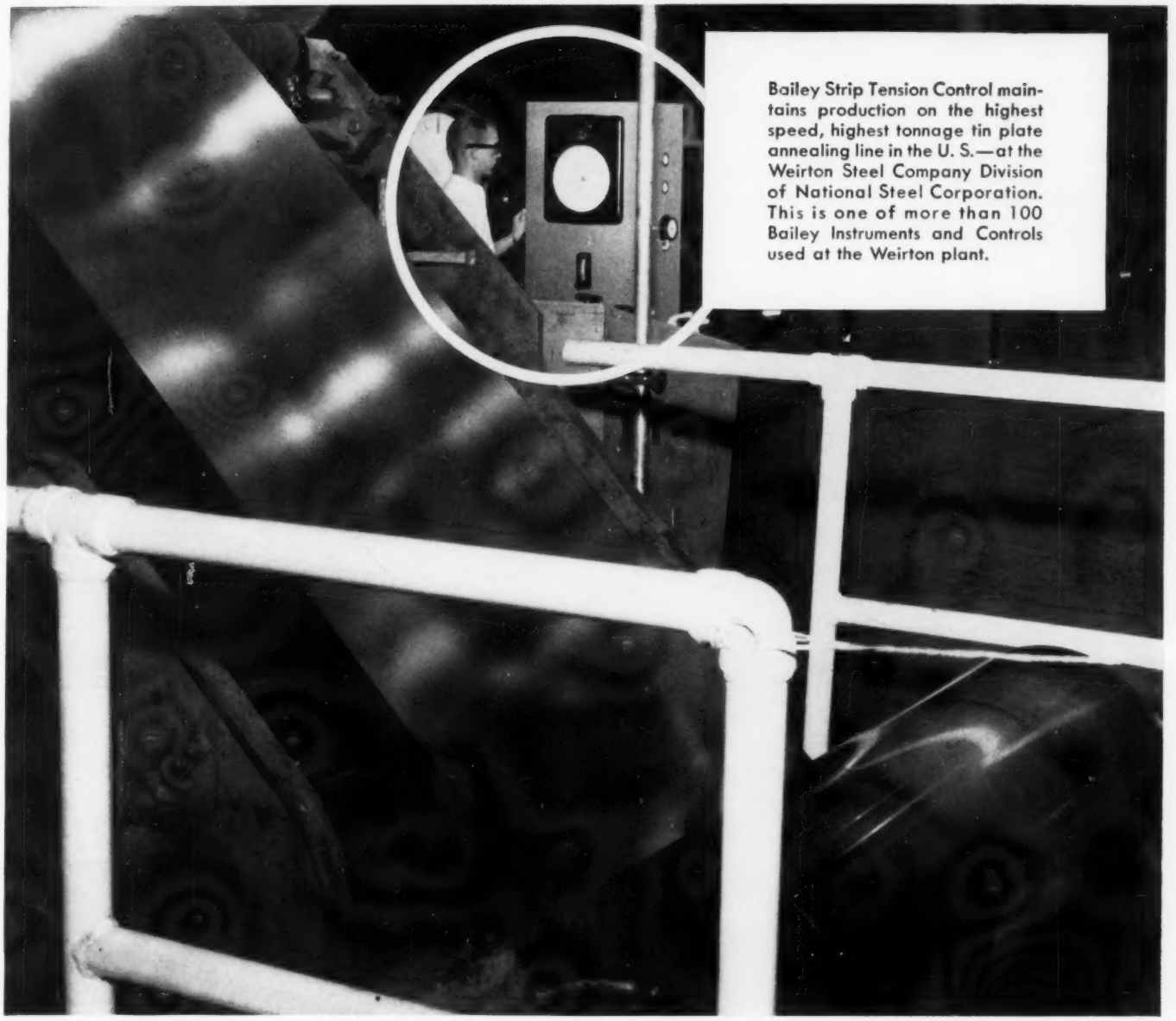
CHAIN CORPORATION
TONAWANDA, NEW YORK
NEW YORK • CHICAGO • CLEVELAND
LOS ANGELES • SAN FRANCISCO
In Canada: McKinnon Columbus Chain Limited, St. Catharines, Ontario



Bailey Strip Tension Control maintains production on the highest speed, highest tonnage tin plate annealing line in the U. S.—at the Weirton Steel Company Division of National Steel Corporation. This is one of more than 100 Bailey Instruments and Controls used at the Weirton plant.

Strip keeps rolling when Bailey keeps an eye on it

Installing Bailey Strip Tension Control will cost you far less than a single strip breakage in a furnace due to poor tension control . . . and it's the surest way of ending tension problems.

Strip tension at speeds up to 2000 feet per minute is pre-set, controlled, and recorded by this unique system. Bailey S.T.C. eliminates undue instantaneous strains through natural 'cushioning' of pneumatic control. It helps maintain strip flatness during finishing operation by minimizing slack formations, and it simplifies strip tracking by holding tension within allowable limits.

If you roll strip, see your Bailey Engineer about Strip Tension Control, or write the Iron and Steel Division for more information.

S114-1

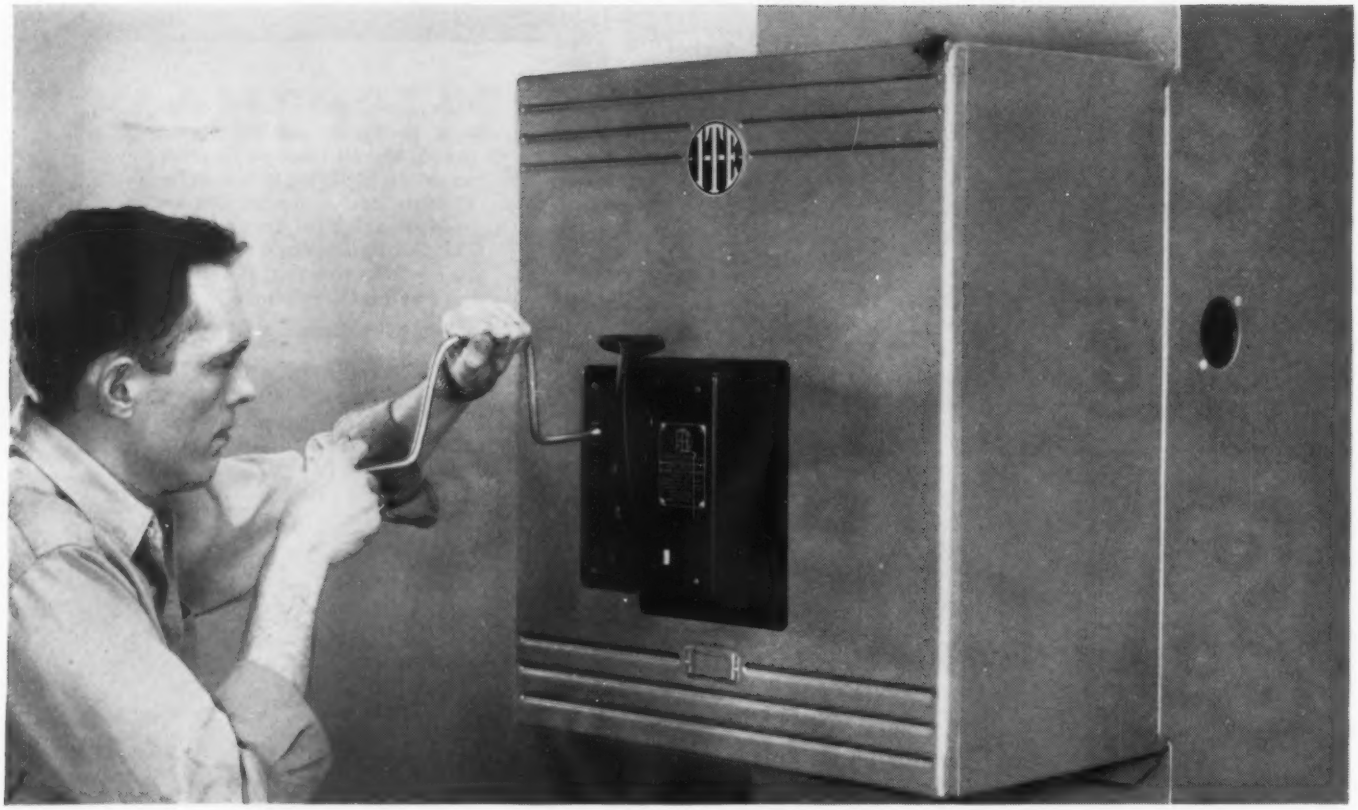
IRON AND STEEL DIVISION

BAILEY METER COMPANY

1047 IVANHOE ROAD • CLEVELAND 10, OHIO

In Canada—Bailey Meter Company Limited, Montreal

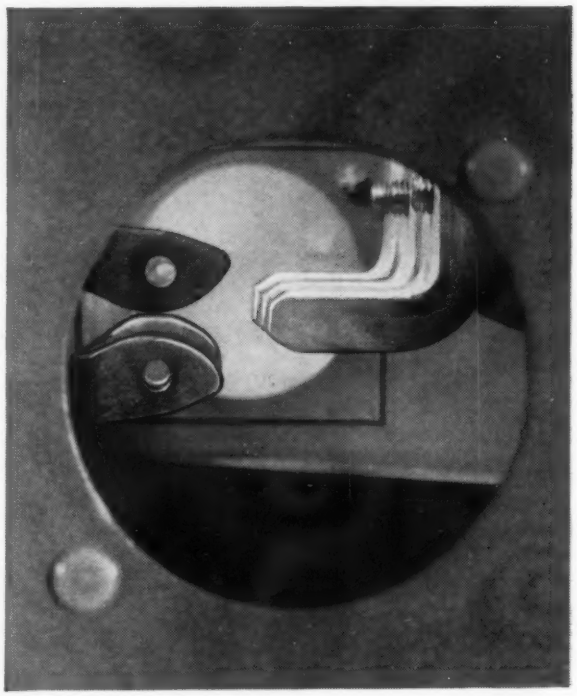
BAILEY METERS



Urelite® gives you double safety

Exclusive with I-T-E

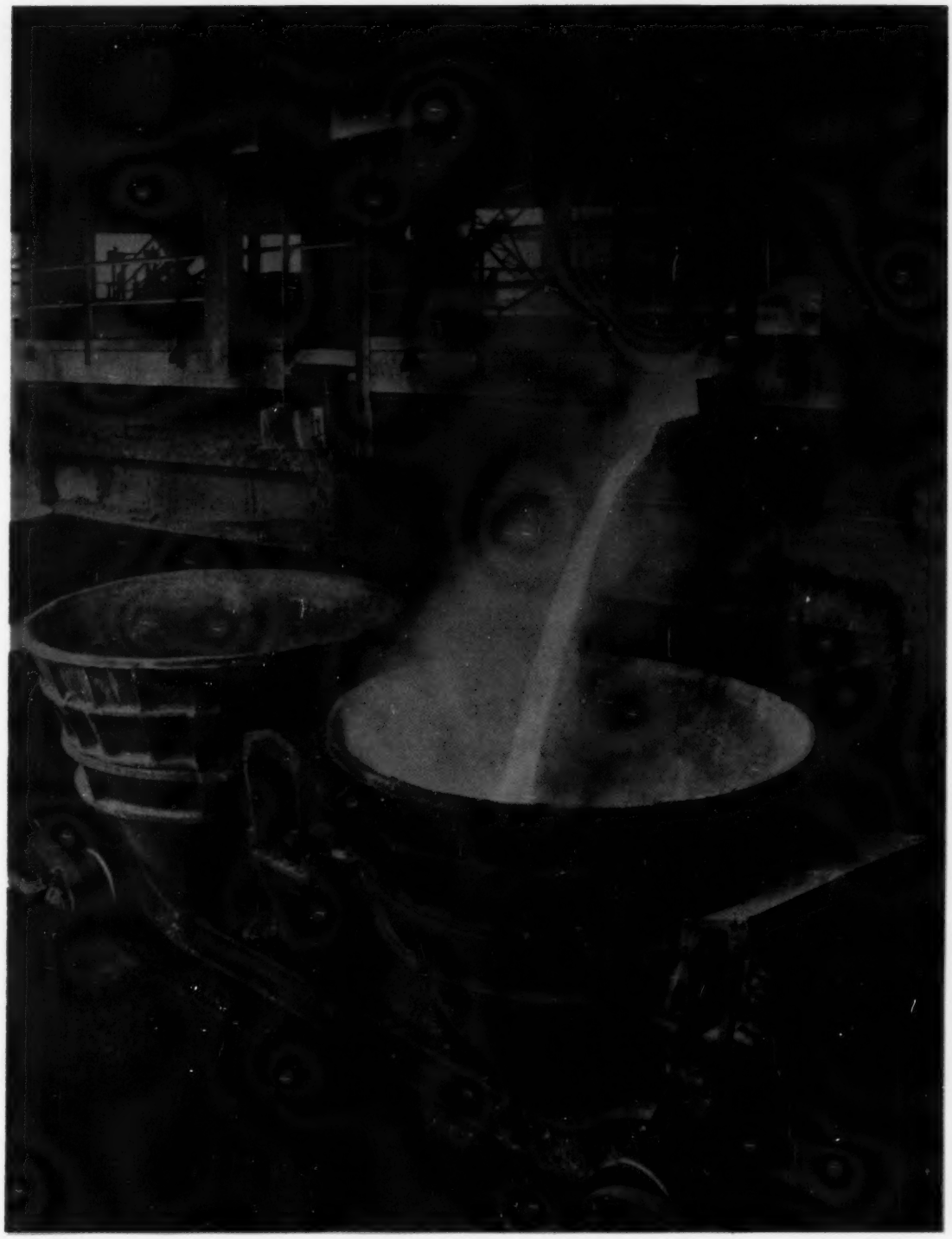
Independent drawout design
Visible separable contacts



In an individually enclosed large air circuit breaker, you couldn't ask for more safety than the I-T-E URELITE gives you. To disconnect it, just insert the crank at the front and turn. Cover need never be removed. A look through the side window positively shows you the position of the separable contacts. Also, with the circuit breaker open, it can be padlocked safely in either connected or disconnected position.

The whole truth is that URELITE breakers are unmatched for exclusive safety provisions, and for low-cost installation, easy access, longer contact life, and adjustable overload devices for higher loads. They handle circuits up to 600 volts, 15 to 4000 amp continuous and 150,000 amp interrupting. Write for new bulletin 4261-2B. I-T-E Circuit Breaker Company, Dept. LA, 1900 Hamilton St., Philadelphia 30, Pa.

I-T-E CIRCUIT BREAKER COMPANY



save time and cost with twin-pot cinder cars

Modern steel plants are becoming increasingly conscious of the benefits of twin-pot, electric-dump cinder cars. When used in preference to a pair of single-pot cars, substantial savings in both first and operating costs can be realized.

A Treadwell twin-pot car, like the one shown, will transport more slag per movement—cutting handling and maintenance costs. Furthermore, it provides greater pot capacity for a given track length. Capacity of pots are 400 cubic feet each.

Treadwell cars can be designed for delivery on their own wheels—ready for service at arrival. You save time and money. They are furnished of cast or welded steel construction, with friction or antifriction truck bearings.

Alternative designs include air-dump cars, and cars with three or four pots of smaller capacity. In fact, Treadwell engineers specialize in meeting customer specifications and service requirements to a T. Remember, more than 2000 Treadwell cinder cars have been placed in service.

For full details, send for a copy of bulletin 61.

M. H. TREADWELL COMPANY, INC.
140 Cedar Street, New York 6, N. Y.
1015 Farmers Bank Bldg., Pittsburgh 22, Pa.
208 So. LaSalle St., Chicago 4, Ill.

TR-27

TREADWELL
CINDER CARS

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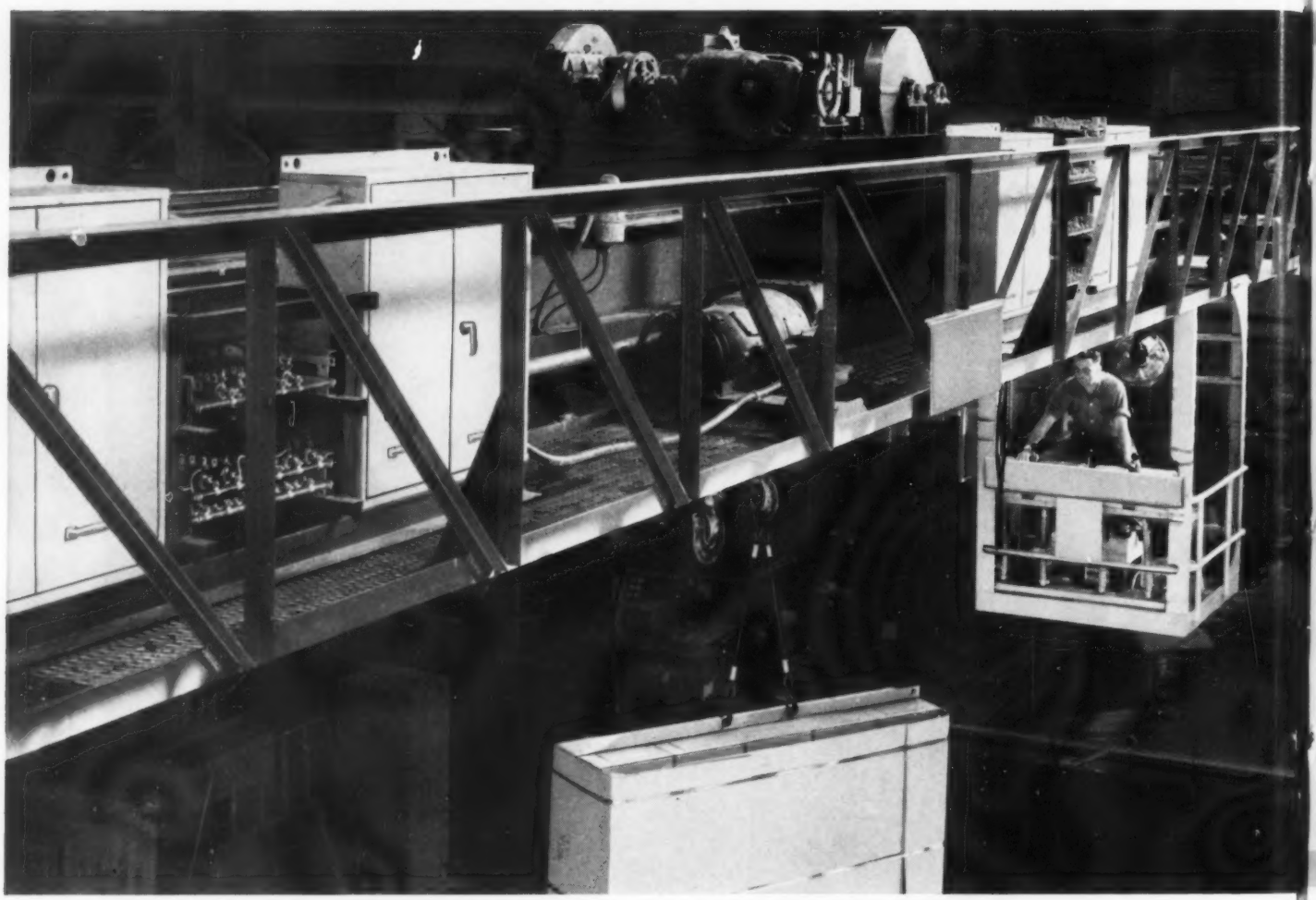

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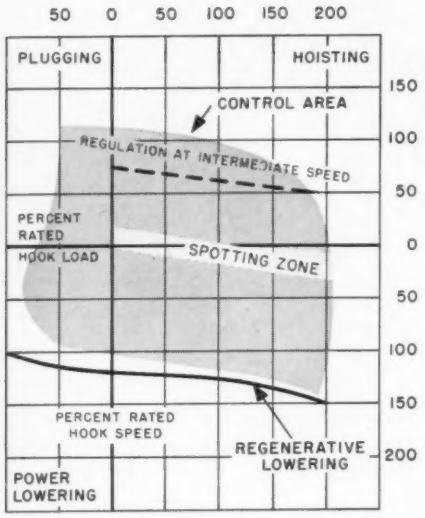

PERFORMANCE CHARACTERISTICS of General Electric's IC7406 static crane control.

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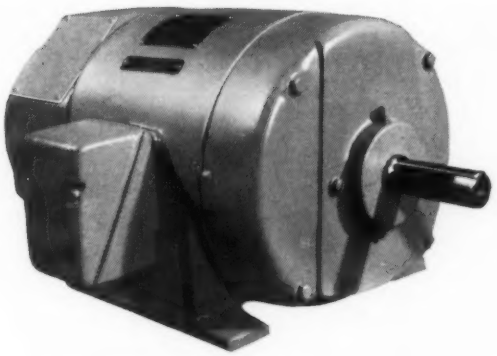
Reverses statically with no moving parts	✓		✓	
All magnetic components—no electronic tubes	✓		✓	✓
Balanced motor currents	✓	✓		
"Spotting zone" control for accurate positioning	✓			
Control from one master switch	✓	✓		✓
Completely stepless control	✓			
Total number of power contactors	1	2	3	8
Total number of relays (excluding overload relays)	2	4	6	13
Eliminates secondary accelerating contactors and relays	✓	✓		
Eliminates need for both electrical and mechanical load brakes	✓		✓	✓
Trolley collectors required	9	10	10	10
Flat speed-torque characteristic on *all* master switch positions	✓			



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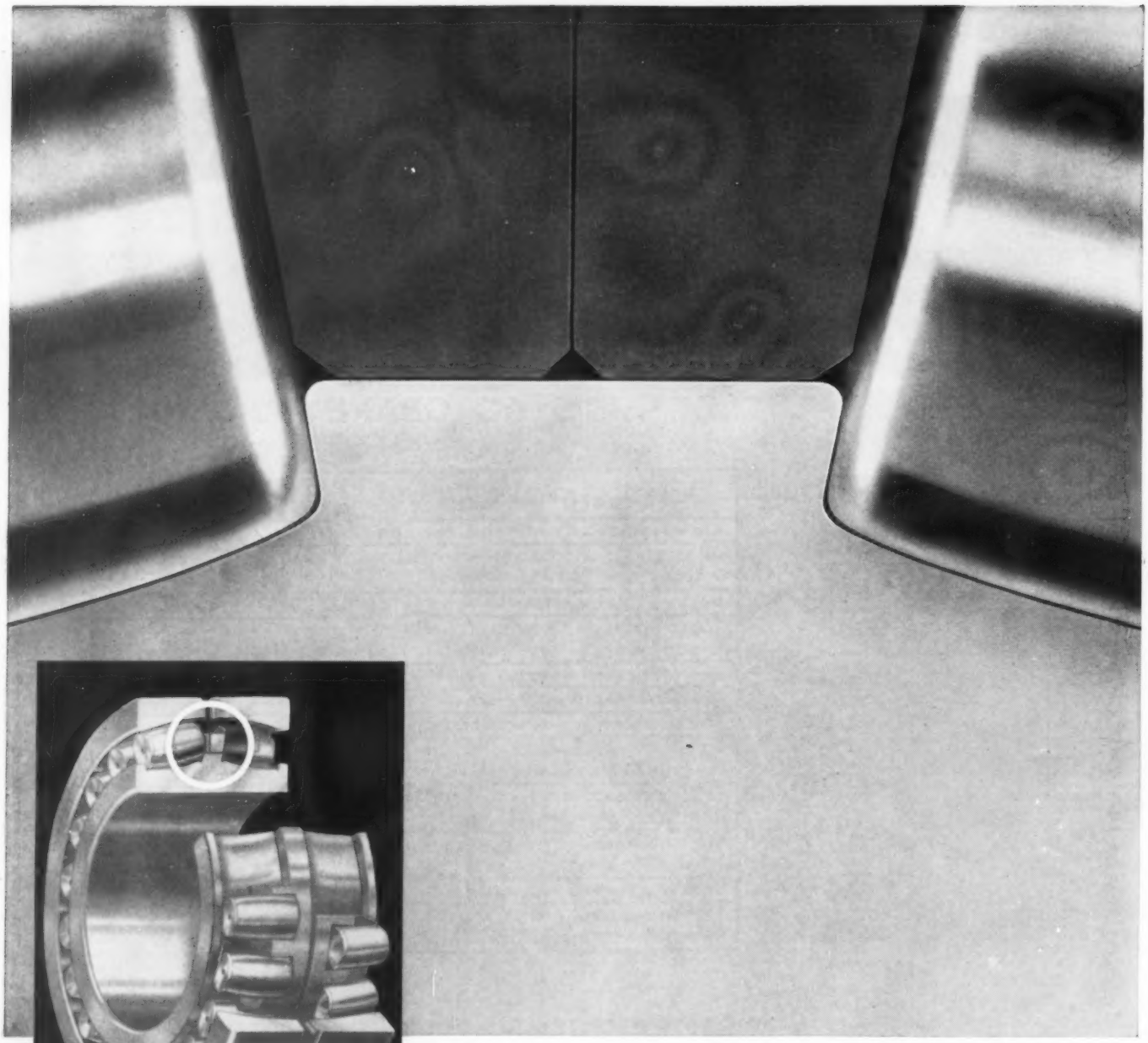

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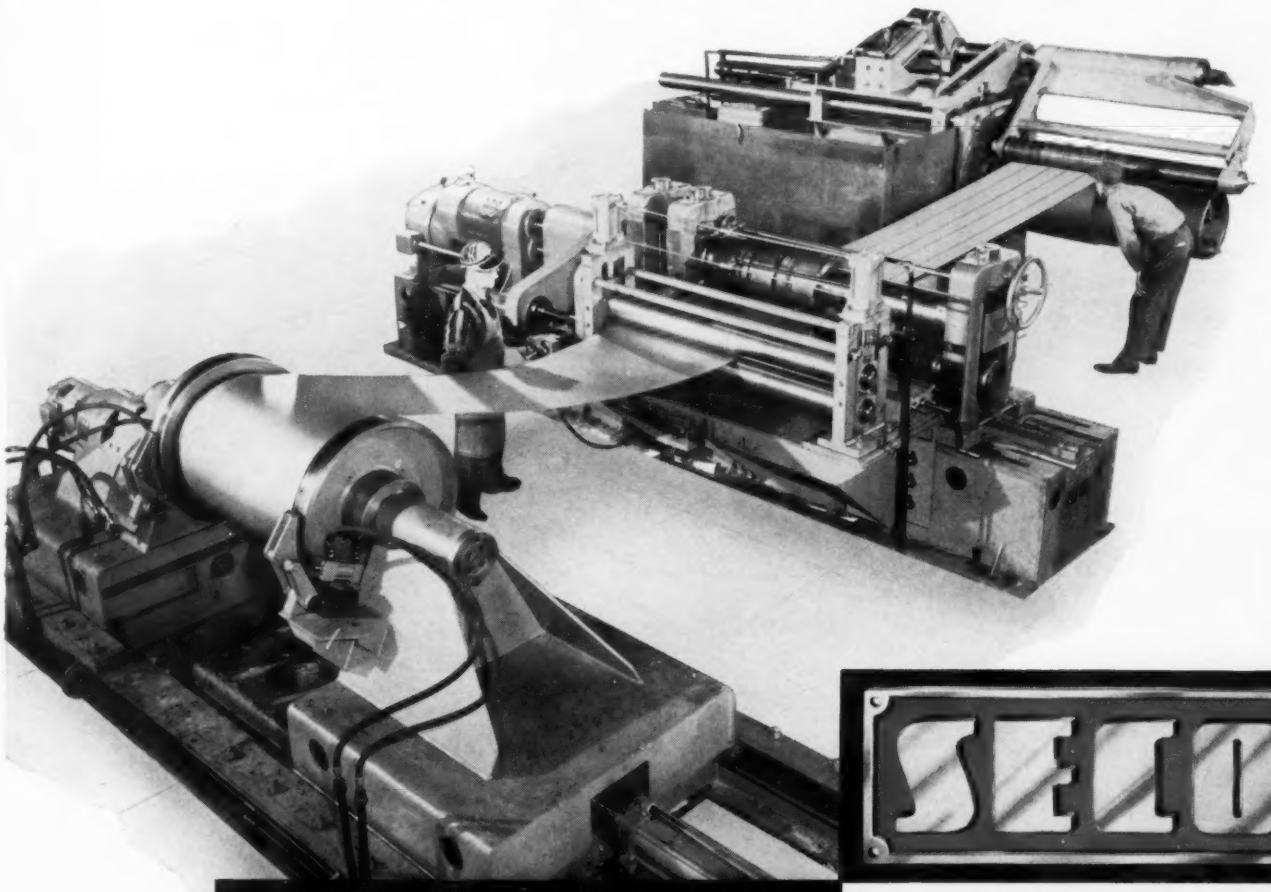

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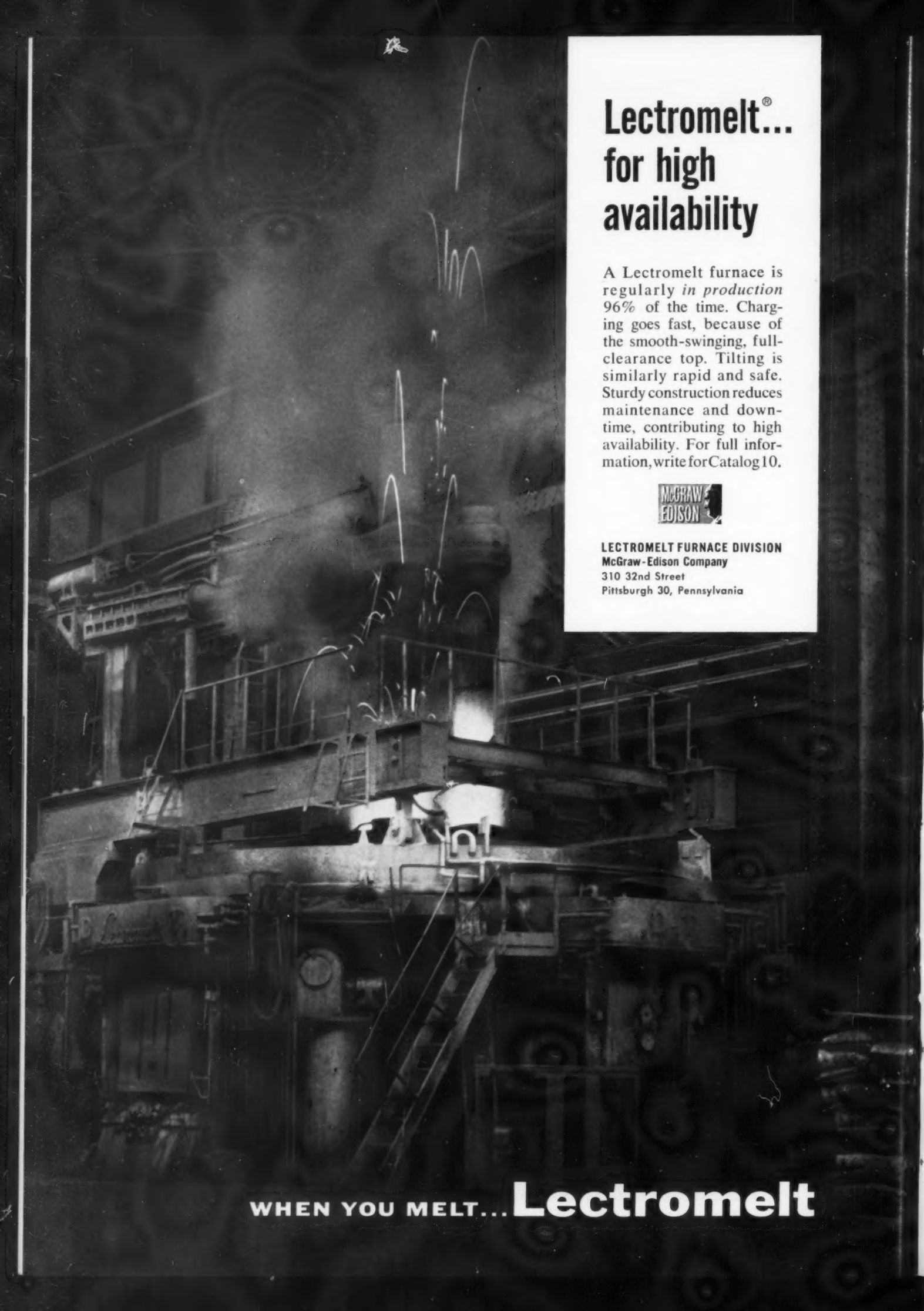

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EOT Crane Runway Rail Installations

. . . . by following five principles of design and construction, many wheel and rail problems that exist today can be overcome . . . .

by W. J. TUNNY,
Superintendent Electrical Maintenance
Youngstown Sheet and Tube Co.,
East Chicago, Ind.

PROBABLY, few things have created so many controversies in the mechanical as well as in the chemical and metallurgical fields as have rail designs and methods of installation. However, it is not the intent of this paper to produce solutions to all of the factors involved in poor crane rail performance, but to offer for future study, test and analysis, some of the major ills, which have been confronting the various groups of crane maintenance people responsible for its best performance.

The problems are too numerous to mention, but most of them center around a few of the most significant which, basically, are as follows:

1. Rail design.
2. Chemical and metallurgical processes.
3. Various methods of installing rails on the crane runways.
4. Methods of joining rails to make continuous lengths on the runway.
5. The pertinent detail of the wheels, both driver and idler.

Rail design has been changed many times in the past. Each change resulting in some improvement over the previous one. The design of the rail must of course embody certain factors to provide the necessary strength to maintain the load in a straight line regardless of how the thrust load is placed upon it. Also the design of the ball of the rail must be such that it conforms to and works in conjunction with the design of the wheel tread and flanges so that the wear on both the wheels and the rail is normal or below normal and the force against the flanges of the wheel is such that the maximum strength of the wheel flange will be able to assert itself, thereby, resulting in less wear of wheel flanges.

The design of the rail head and the slope of the wheel flanges must be co-ordinated so as to cause the least amount of wear when contact is made between the rail and the wheel. A rail having a flat head should not be used with a wheel that will result in premature wear and peening over the edges of the railhead because of improper contact of the wheel to the rail. An improper application of wheel tread design will definitely result in rapid wear of both the wheel and the rail. Each installation must be given careful consideration and a study should be made of all factors involved such as span, wheel, base, etc., which will result in a combination of good wheel and rail performance.

Two major problems are encountered by those who must either design a crane runway or maintain one: first is to secure a rail that will have a long life under heavy loads, thus extending the cycle of costly and difficult replacement; second, is to install the runway rails in such a manner that abuse to the crane, runway supports and the rail itself will be minimized, thereby eliminating excessive maintenance.

Three special rail sections for crane runways and other heavy-duty requirements are provided for the ranges of wheel loads encountered. A crane rail section no. 17551 and companionate joint bar is recommended for wheel loads exceeding 109,000 lb similarly, crane rail section no. 13551 is recommended for wheel loads in the range of 80,000 to 109,000 lb, and crane rail section no. 10551 for wheel loads up to 80,000 lb.

Chemical and metallurgical processes used in the manufacture of wheels and rails have varied considerably in the past and probably will continue to change in the future because it is always necessary to search for better performance, longer life of material and less wear of these parts. There must be economical balance achieved between the wear of wheels and that of the rails so that the cost of prematurely changing one or the other, or even both will be minimized.

In some cases of crane rail installations, experimental work must be carried out after the equipment has been placed in service because other variable factors must be given attention. This may result in the use of a rail design not conforming to the ordinary but special to that particular runway.

One steel plant manufactures rails and hardens as follows:

They heat the full width of the rail heads, longitudinally on the running surface 3½ in. to a depth not less than ¼ in. The heated area is quenched with 72-psi air pressure to avoid the presence of martensite in the steel structure.

The resulting Brinell hardness is as follows:

Nominal Weight Per yard, lb	Permissible range in Brinell hardness
90 to 120	331–401
121 and over	341–415

Design engineers and maintenance personnel are con-

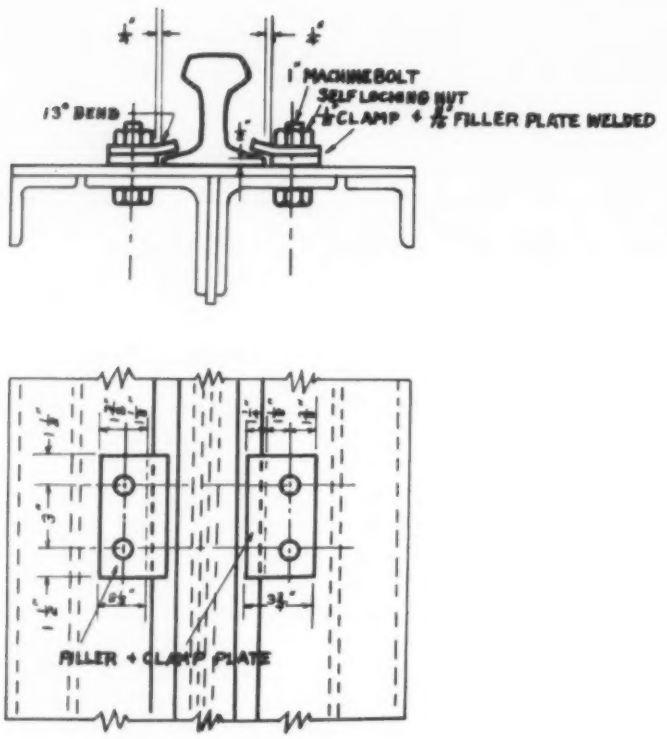


Figure 1 — This rail clamp permits lateral movement.

stantly on the alert for methods and materials that will minimize troublesome and costly shutdowns of equipment for repair and maintenance. Perhaps the most aggravating problems that face those who have overhead cranes are the ones that occur when it becomes necessary to renew crane runway rails or take the crane itself out of service for repairs brought about by an improperly installed runway or one in a bad state of maintenance.

Crane rails are not self supporting and therefore must have a suitable and proper runway to set on. The elevations of two respective runways must be level to minimize the wear to the rail head and the flanges of the wheels. The use of a wearing plate improves the performance of rail life.

Many different types of rail fastenings are in use but there are two major differences in them. One type maintains the rail in a fixed position allowing lateral movement. This rigid installation is recommended with the use of taper tread wheels and prevents the crane from having excessive end movement and also keeps the rail from spreading so that severe flange wear of the wheels does not occur. These rigid clamps are designed to clamp the rail in one position and not permit any movement.

The other type of rail clamp is designed in such a way as to permit the rail lateral movement, shown in Figure 1. This installation is called a floating rail. A certain limited movement within the clamps is beneficial on some crane operations and improves the wheel and rail performance by increasing the length of service. Wheel flange wear is considerably reduced by keeping the pressure of the contact between the rail and the wheel flange to a minimum.

Movement of the rail is permitted by making the filler plate slightly thicker than the rail at the edge of the base and by bending the clamp plate so that clearance exists with the rail base. The clamps and filler plates are fastened to the runway structure with two bolts which keep them in alinement with the rail and set so the filler plate clears the edge of the rail. This clearance is described as float. The clearance eliminates any possibility of binding between the rail and clamps and allows free expansion and contraction to take place, removing objectionable strain on the joint bar bolts which is caused by tight clamps. The float or lateral clearance between the rail base and clamp permits an adjustment between the wheels and rail due to uneven crane travel, thus reducing wear on the crane wheels and bearings.

There are many variations of these two types of clamps, each one styled to do a specific job according to the requirement. Naturally the clamp and the method of holddown must be strong enough to withstand the forces exerted by the movements of the crane wheels on the rails.

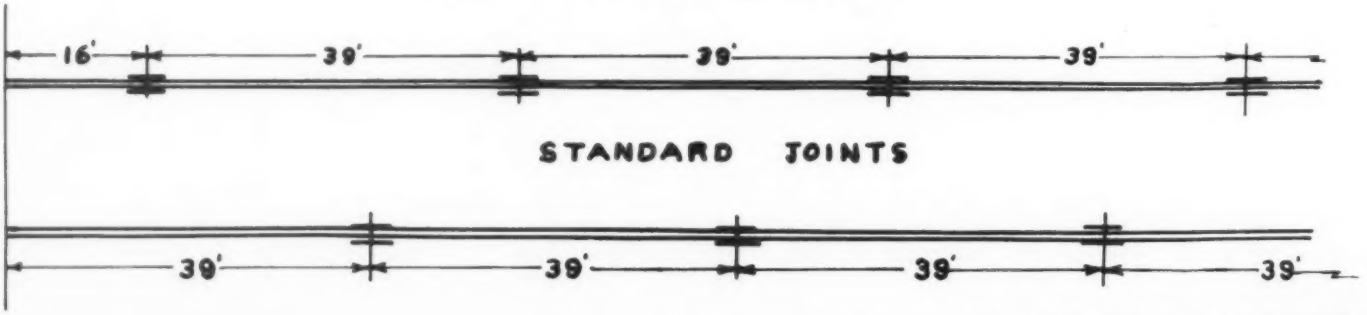
It has been the practice of many design engineers to fasten crane rails securely along the runway and to locate the rail joints at each column in the supporting structure to provide allowances for expansion and contraction.

The principle of the advocated practice is to permit limited freedom of the rail movement both laterally and longitudinally when using flat tread wheels. Limitation of lateral movement is achieved by the use of the clamps, while longitudinal movements is limited by a rail stop plate at each end of the runway.

Of most significance, is elimination of the necessity for locating rail joints near runway support columns to allow longitudinal expansion and contraction. A typical plan showing a 250-ft runway would require several standard 39-ft length rails and two rails, each 16 ft long. See Figure 2. It is important to note the recommended position of the two 16-ft pieces which are located at opposite ends of the runway so that the joints are not opposite each other.

Anchorage of the rail to arrest its creeping with crane movement can best be accomplished by providing a rail stop plate as part of the crane bumper. Distance

Figure 2 — In rail layout, joints are staggered.



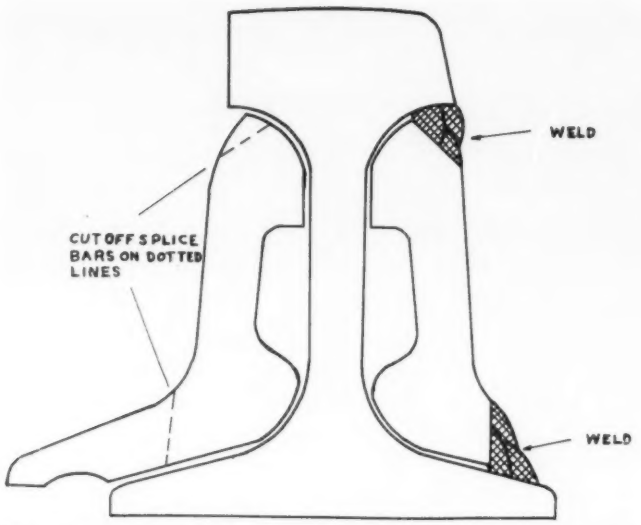


Figure 3 — It is desirable to weld splice bars to rail flange and ball.

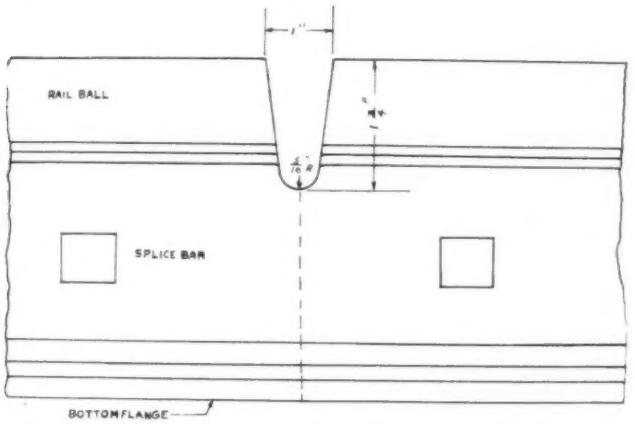


Figure 4 — All slag and scale should be removed from gas cut surfaces.

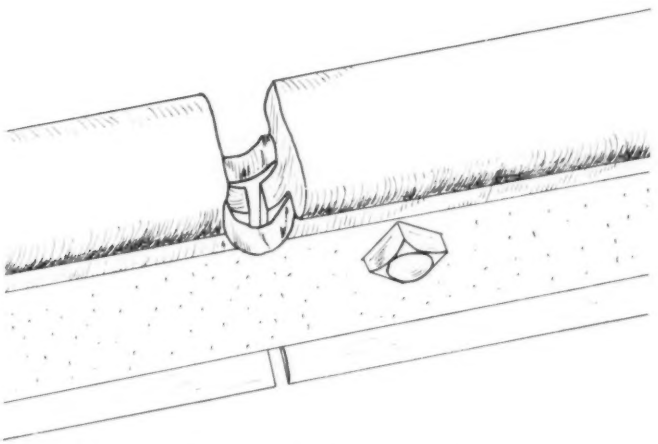


Figure 5 — View shows joint before welding.

from the end of the rail to the stop plate at the time of installation should be a minimum of 3 in., or longer if needed to provide for the maximum length of the rail at the highest temperature anticipated.

The age old problem of making satisfactory rail joints is still an aggravating one and has been handled in more different ways than other phases of crane runway rail installations. It immediately follows a new crane rail installation and is always present on old installations.

The use of splice bars and bolts still remains a very

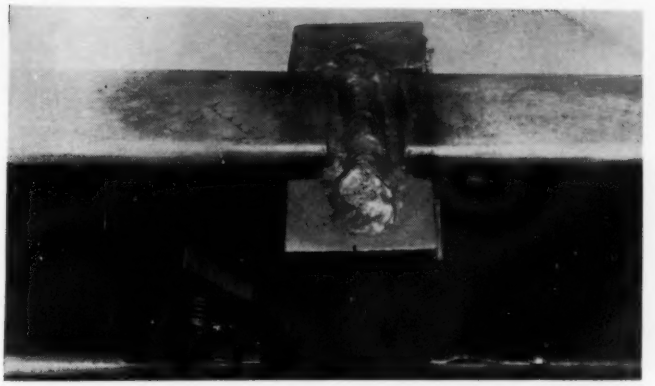


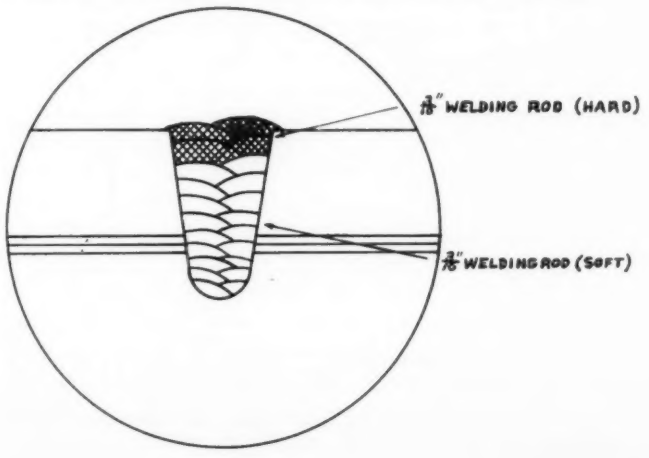
Figure 6 — Weld beads can be started and ended on lugs instead of on joints.

popular method and is low in initial cost. An improvement over that is the use of milled rail ends and rail and splice rail ends forced tightly against each other. This results in a longer period of good rail support. A future improvement of this continuity is brought about by welding the splice bars to the rails with the purpose of preventing the gradual separation of the rail ends from taking place thus resulting in a gap which is detrimental to the rail ends.

In addition to this a method has been in use which provides a definite gap between a certain percentage of the butted ends of the rails which are filled with material by electric welding. This procedure must be carefully done with material which will result in a finished weld closely conforming to the material of the rails. A rail joint of this type presents a working surface to the tread of the wheel that is very similar to the head of the rail itself. This particular joint can be made on rails that are worn as well as new rails and results in greatly prolonged life of rails that otherwise would have needed replacement because of badly worn joints which cause severe damage to parts of the crane. The joining of rails by welding is the most desirable method of joint assembly. It is important that the weld be properly made, both with regards to method and practice, or breakage will be encountered.

To obtain a strong joint, it is necessary that the splice bars be welded to the rail flange and ball. It will be found that most types of splice bars over-hang the flanges of the rail and must be carefully gas cut so that they can be welded properly. For those installed it will be necessary to remove the splice bars from the rails

Figure 7 — Joints are built up with two types of rod.



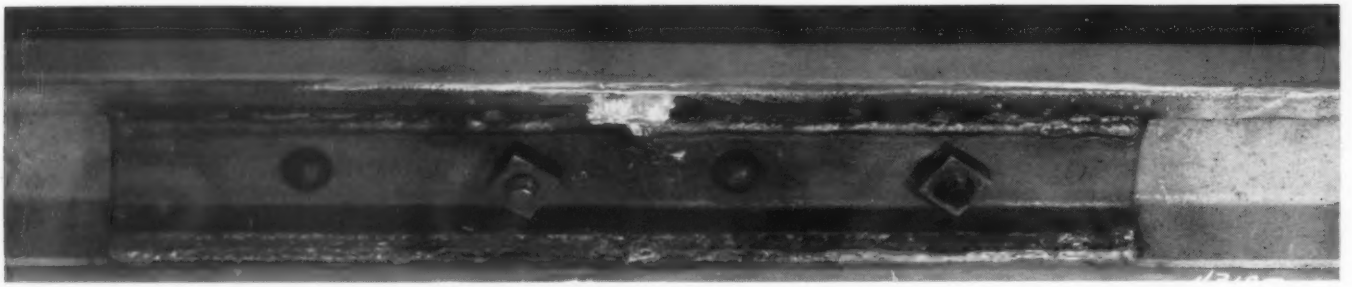


Figure 8 — The result is a smooth surface.

and gas cut them as shown in left side of Figure 3. It will be found that distortion due to gas cutting can be minimized by using a back stepping method of cutting, that is, starting the cut in the center of the bar, then starting at the left end and cutting to the center. Before reassembling the splice bars, the groove between the rail ends should be prepared as shown in Figure 4. All gas cut surfaces should be properly cleaned to remove all slag and scale from gas cutting. A typical view is shown in Figure 5.

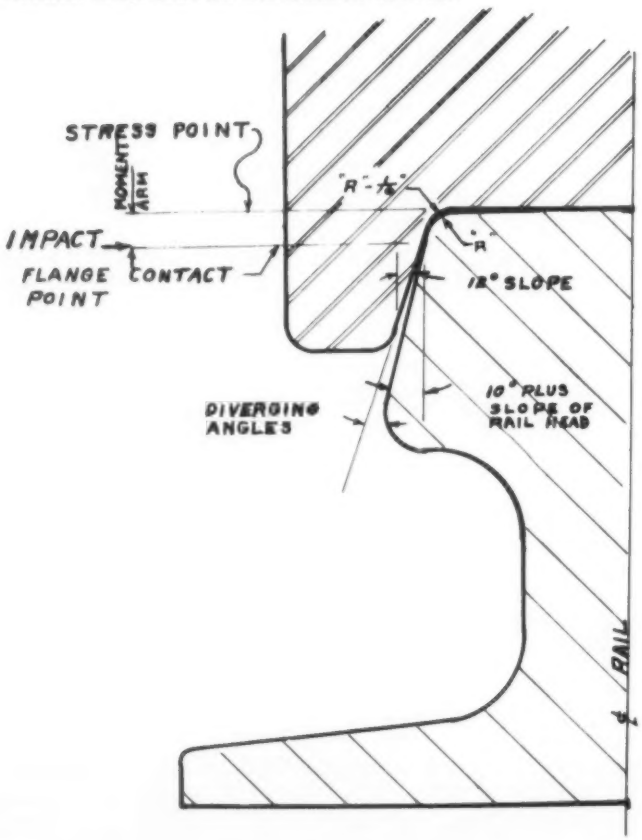
After assembling the splice bars with several bolts to hold the joint rigid, the joint should be carefully preheated for a distance of 6 in. on either side to a temperature of 350 to 400 F. A three-pass horizontal fillet weld should be made on each side of the splice bar as shown in right side of Figure 3. A $\frac{3}{16}$-in. electrode using 220–230 amp d-c, reverse polarity should be used. A back-step method of welding is required, that is, starting the bead at the joint and welding toward the right end of the bar. The second bead is started at the left end and welded toward the center of the bar. Welding should be alternated from side to side.

After the splice bar has been welded completely, the groove is started. Starting lugs should be used on both sides of the joint so that the weld beads can be started and ended on the lug rather than in the joint as shown in Figure 6. Each bead must be cleaned thoroughly after welding and all slag and scale removed before depositing the next bead. Bead sequence is as shown in Figure 7, that is $\frac{3}{16}$-in. diameter soft rod is used until the last $\frac{1}{4}$ in. The last two to three layers or $\frac{1}{4}$ in. of the groove is filled up slightly overflush using $\frac{3}{16}$-in. hard rod. It is suggested that the weld reinforcement be ground from the top of the joint while the weld is still hot, to eliminate grinding cracks.

After the weld reinforcement has been ground flush with the top of the rail, the joint is to be reheated to a temperature of 350 to 450 F. About one foot on either side of the joint. The joint should then be covered with an asbestos or cloth wrapping to allow it to cool as slowly as possible.

It is estimated that a joint like this can be made by two men in three hours using about 10 lb of electrodes per joint. Tests have indicated that soft electrodes are satisfactory for the body of the weld and hard electrodes are satisfactory for the hard facing of the weld and gives hardness values very close to that of the rail. A finished rail joint is shown in Figure 8.

Figure 9 — Wheel flange should have a radius $\frac{1}{16}$ in. smaller than that on the head of the rail.



Certain factors of a crane rail installation are governed by the design of the wheels of the crane that are going to operate on them. The design of the rail head, especially the top of the rail will be determined by whether the wheel tread will be flat or tapered. On a flat head contact between the tapered tread and the rail will be a small area resulting in very rapid wear of the rail.

The metal will readily be peened over the edge of the head and decrease the free area of the tread resulting in a decrease of the lateral movement of the crane. For taper wheels the head of the rail should be rounded on top. As rail wear takes place, the area of contact between the rail and the wheel tread will increase.

Taper tread should be used for structures which are not too rigid, where a number of cranes are used on the runway and where small amount of weaving is not objectionable, provided end clearance permits lateral float. On long runways, not rigidly trussed, where a series of runways are tied together, allowing lateral force setup by adjacent cranes affecting other runways, taper treads should be used.

Flat tread should be used on structures properly trussed and considered quite rigid, to prevent lateral movement, particularly on single runways, and on short runways, having only one crane, where wheel changes would cost less than complete rail renewal.

A flat tread or taper tread will work equally well on a

ball or convex headed rail. The taper tread is better on a long span, short wheel base crane, while the flat tread produces good results for a short span, long wheel base crane. By way of explanation, a long span, short wheel base crane is one where the ratio of span to wheel base exceeds 6 to 1.

When designing wheel flanges, a radius $\frac{1}{16}$ in. smaller than the radius on the head of the rail should be used, see Figure 9. This is done to avoid having the head riding up on the radius of the wheel tread. One exception to this rule exists, that is, when the radius of the rail head drops to $\frac{1}{4}$ in. Then make the radius of the flange to the same radius as on the rail head.

Use 10 degrees on all straight-sided rail heads. However, on the CIS 135 and 175-lb rails, slope the flanges to 12 degrees. These rail heads carry a 10-degree slope on their sides, and diverging slopes insure against the rail head side contacting the flange out on the tip, or outside diameter of the flange. If contact should be made at the tip of the flange, considerable stress is set up, causing excessive wear and breakage of wheels and rapid wear of rails.

Those having the responsibility of installing and maintaining crane runway rails should consider the five significant points of this paper. If they are given due consideration it is believed that many of the wheel and rail problems that exist today may be overcome.

Discussion

PRESENTED BY

ROSS B. McCREADY, Director of Engineering, Alliance Machine Co., Alliance, Ohio

W. J. TUNNY, Superintendent Electrical Maintenance, Youngstown Sheet and Tube Co., East Chicago, Ind.

H. H. ANGEL, Electrical Engineer, Construction Engineering Dept., Bethlehem Steel Co., Bethlehem, Pa.

JOHN F. HEADLEE, Engineer, Arthur G. McKee & Co., Cleveland, Ohio

RICHARD J. OSBORN, Superintendent, Maintenance, Rolling Mill, Steel Div., Ford Motor Co., Dearborn, Mich.

Ross B. McCready: As crane manufacturers, we have realized for some time that it is impossible to talk about crane runway rails without talking about crane wheels and other related factors.

In regard to Mr. Tunny's comments on tapered tread and flat tread wheels, we would like to make the following observation. It would be well to use either flat tread crane bridge wheels throughout or tapered tread crane bridge wheels throughout for a particular crane and not a combination of the two on one crane. The combination, for instance, of tapered tread driver wheels and flat tread idler wheels causes excessive runway rail wear, since the rail head is being worn at two different angles and, therefore, good contact will never be realized.

In regard to the use of flat head crane rails, the only popular flat head crane rail would be the Bethlehem 171-lb rail. As Mr. Tunny points out, this would not permit the use of tapered tread wheels.

I would like to ask Mr. Tunny the following questions:

When the radius of the rail head drops to $\frac{1}{4}$ in, why should not the wheel flanges be designed with a radius $\frac{1}{16}$-in. smaller than the radius on the head of the rail rather than making it the same size?

Also, would it not be simpler to have all wheel flanges made with a 12-degree taper?

W. J. Tunny: No appreciable benefit is obtained when the rail radius is $\frac{1}{4}$ in. or less by making radius on wheel tread to give $\frac{1}{16}$ in. difference. In any case the radius of wheel flange should not be greater than rail head.

It would be simpler to make them all 12-degree slope, however, the 10-degree slope has been used as a standard for a long period of time and was to accommodate rail heads that were straight sided or nearly so. Later this was questionable when applied to rail heads with 10-degree taper. Therefore it was desirable that a comparable clearance should be provided for the 135 and 175-lb rails which resulted in the 12-degree slope design of track wheel flange.

H. H. Angel: Mr. Tunny has given information which gives just a small idea of some of the troubles which beset steel mill people trying to maintain cranes and runways. I am somewhat familiar with some of the problems our own Bethlehem Steel Co. has in that respect, and there are many. In general, these are the cause of considerable maintenance on very heavy-duty jobs such as in open hearths and in the hard worked blooming and strip mills.

First of all, you have the problem of keeping your crane runways in good condition and that is difficult, especially in some of the open hearth buildings.

Then you have the problem of rail installation, whether you are going to clamp your rails solidly to the runway or have them floating. In our company there is a diversified opinion on this subject. One plant believes in clamping the rails very tightly to girders and another believes in having one or both rails floating.

If your rails are clamped tightly to the runway, you will have less wearing plate wear, but probably more rail and wheel flange wear. If the rail is floating, you have what may be called a "sloppy" job and you may get by with a lower maintenance of rails and wheels. However, you certainly may have more top plate wear which eventually means replacing the top plates or at least putting liners on the top, which is a big job.

You next have the question of the movement of the rail along the runway. I know on some jobs where the clamps are loose and the crane bridge is plugged very hard, sometimes the whole rail may move a few inches to a foot. This has been reported a number of times.

Some of the people claim that the coefficient of expansion of the rail is the same as on the runway. Therefore, there is no reason why you cannot block each end of the rail. You can weld a stop in place to the runway and prevent the rail from moving. Other people claim they have proof that there is an unequal difference in expansion due to the greater heat which the runway may collect compared to the rail itself. I know in several instances in one of our plants, the ends of the rails are prevented from moving and yet in the wintertime you have more space between the joints. In one plant, one of the men has some heavy springs on order. He plans to place very heavy springs between the crane runway and the end of the rail so you do have a little

bit of give there, and, therefore, you will have definite pressure to keep the rails closer together in the wintertime where you normally have a gap between the rails.

We have a number of installations in our plants where we use fully heat-treated rails. In one plant in particular they have used these heat-treated rails for about three years and the results have been very favorable and they are increasing the number of heat-treated rails in instances where they have considerable wear on the untreated rails.

The problem of rail joints has been as Mr. Tunny indicated a very difficult one and it seems that you just cannot get a satisfactory bolted connection unless you keep men on the runway, periodically tightening the bolts fastening the joint bars to the rails and that, of course, is impractical. On some installations you are not allowed to get up on the runway because of the duty service on the cranes.

We have found that the most satisfactory joint is a welded one. In some plants we have had quite good success in welding. In other plants, the success has not been as good and they are rather reluctant to go back to welding. However, with new techniques available, some of the plants which have been against welding are now reconsidering it, but the electric welding of the rail joints without using a joint bar is a very precise art and great care must be used in the proper weldings.

John F. Headlee: A number of years ago in *Iron and Steel Engineer* there were many articles on welding versus bolted design.

The thing that concerns me mostly at the moment is the question of rails and wheels.

I had a thought the other day on the heat-treated rail applied with a heat-treated or rim-toughened wheel. I thought that should be very good, but being an engineer I challenge everything, so I started asking and I obtained some favorable and unfavorable comments.

The point that I want to bring out is that the normal rail which is standard as comes from the rail mill gives better wearing and less maintenance work than the heat-treated rail.

I am wondering if anyone has such experience.

W. J. Tunny: We have found that most of the damage is done at the ends of the rails and for that reason we are asking for hardened ends when we order rails.

Some people I know order the whole rail hardened. I am not sure what the ratio is, but it is certainly a high ratio between the damage done to the end of the rails and the wearing on the ball of the rail.

When the ball of the rail is worn, then, of course, you might as well change the rail, but when the rail end is worn or cracked at the end, why, you can hold that rail in service a much longer time if you have it welded as mentioned in my paper.

Member: I have had a lot of experience on crane rails. I have used heat-treated rails but I have not been able to buy heat-treated rails in the lengths that I want to use for, I do not want to use rails less than 39 feet. The fewer rail joints I have, the less trouble you are likely to get into.

Our company buys, through my recommendation, a 104-lb section Bethlehem rail, 39 ft long. I order them as rolled. When received we sandblast the ball of the rail. These are then shipped to a processing company for flame hardening to our specifications. Then they are shipped back to us, with a slight curvature upward at the ends.

They come back with a hardness of approximately 600 to 650 Brinell. We draw them back to get a hardness of about 400 Brinell. Now, this hardness will run approximately $\frac{3}{16}$ or $\frac{1}{4}$ in. deep at the top of the ball and down around the sides. I do this for one reason, as I only use these rails on our heavily-traveled runways, with high-wheel loads of approximately 70 tons.

On the light-loaded cranes this practice is not used. This costs about 85¢ a running foot for flame hardening. I cannot give the figure it costs to draw it back, but I would say $8 an hour in our furnace, and they have to be in there approximately 12 hr to get back to the Brinell hardness that we want.

Along with that, we use a special splice bar with heat-treated bolts and high-chrome lockwashers, the thick ones, about $\frac{3}{8}$ in. thick.

I have tried welding processes, I have electric welded, I have acetylene oxygen welded and acetylene oxygen welding is the best of the two.

You can get it done the way you want it if you are on the job to see that the welders do it the way you want it. I gave up because I cannot seem to keep two welders doing exactly the same thing that I want. I ran a comparison between acetylene-welded job and the splice bar job and the splice bar job outlasted the other two-to-one.

I also block one end of my rails at one end of the building. I spring load the other end. I do not use a floating rail. I use a snug rail, but not a tight rail.

I also use tapered drive wheels on my drivers, but not on my idlers. To do this we have to allow extra flange clearance on the tread wheels because we allow no float whatsoever on the crane itself. We get that float on the tread of the wheels.

I have not experienced any great trouble on wearing my rails out from a straight tread wheel and a tapered tread wheel wearing together. They will eventually, but not too fast on heat-treated rail.

In our stock house I have heavy wheel loaded cranes. An ordinary crane rail would give me one year's service. The heat-treated rail gives four years' service at practically double the cost of the rail. The heat-treating is costing me as much as the price of the rail when I buy it, so one can easily figure whether I have any saving or not.

Richard J. Osborn: We have one very busy 1100-ft runway now using 104-lb heat-treated rail. It was originally installed with standard 39-ft lengths, non-heat-treated, with bolted joints.

We have gone to 60-ft lengths of completely heat-treated rail with welded joints, no splice bars, no joint preparation. We simply butt the rail ends with a slight gap and weld them.

We experienced about 18-months' service with the first set of bolted joint, unheat-treated rails. We began replacing these rails with the longer lengths two years ago this month and so far have had perhaps six broken welds. You have to be on top of the welder when he does the welding, but the rails show little wear. The joints are in good condition and the 60-ft lengths of rail, while they are somewhat cumbersome to install, do eliminate a lot of joints, and we are very happy with the application. ▲

CRANE BRIDGE
Drive and Wheel Combinations

. . . . the solution to the overhead crane wheel and track problem may well be a combination of separate end drives with single outside flanged wheels or equivalent . . . .

by ROY F. DEHN,
Director of Engineering
The Cleveland Crane & Engineering Co.
Wickliffe, Ohio

A GREAT deal has been written about overhead crane wheels and drives. This discussion is a review of the various combinations of wheels and drive arrangements generally used with some added comments on the problems and their solution.

First, consider the combination of straight tread double flanged wheels with a lineshaft drive. With this combination (Figure 1), unequal wear of the drivers and consequent unequal diameters cause the crane to be driven in a circle of large radius. After reaching the maximum skew the tread clearance will permit, the crane will skid along in the skewed position. The result is excessive flange rubbing and periodic slipping of one driver wheel and chattering of the lineshaft. The lineshaft and drive gearing from wheel to wheel resists the rpm differential until one wheel, either the smaller or lighter loaded wheel, slips.

In the case of a double lineshaft bridge drive, the diameters of all four drivers could be bucking each other. In the case of a broken or rolled over flange the crane could actually drive itself off the rail.

When straight tread wheels are used with a lineshaft, even with drives of exactly equal circumference, the crane will not necessarily run true because of braking, acceleration, etc., and there is nothing provided to straighten up the crane after skewing.

The usual remedy is to slam the crane against the runway end stops. This only results in winding up the lineshaft which unwinds again as soon as the crane has traveled, resulting in going back into the skew. It would be of help to hit the end stops if one driver was jacked up to permit the lineshaft to unwind in the square position.

After experiencing frequent replacement of wheels, the user tendency is to go to hardened wheels, which under a skewing condition will cause excessive rail wear and replacement unless hardened rails are used.

Second consider (Figure 2) the combination of taper tread double flanged wheels with a lineshaft drive. The

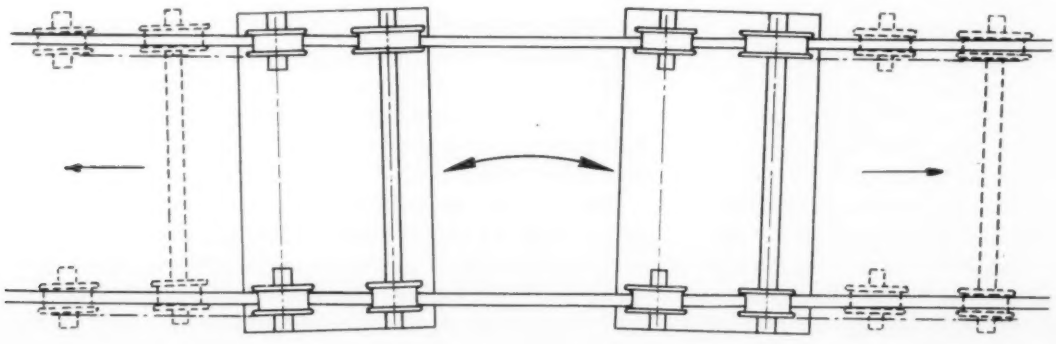


Figure 1 — Straight tread wheels connected with a lineshaft will not track evenly if the wheels are worn unevenly.

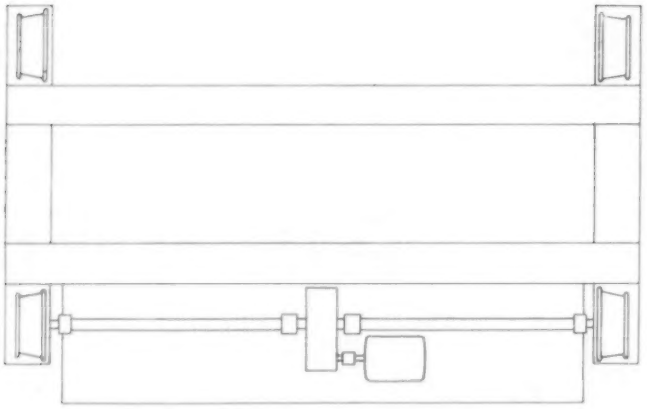


Figure 2 — Taper treads help compensate for bad tracking due to unequal wheel diameter.

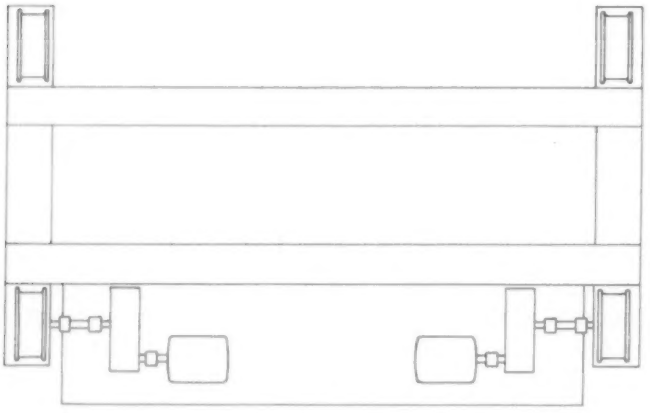


Figure 3 — When a crane is driven from both ends without a lineshaft the motors will slip enough relatively to keep crane in line.

generally accepted solution to wheel alinement problems when a lineshaft is used is wide taper tread wheels which are self squaring, having the inherent tendency to find equal running diameters.

Many of our crane installations have operated several years in heavy duty service without noticeable flange rubbing, the paint or finish marks still showing on the inside of the flanges.

Driver wheels should be remachined as soon as tread wear allows serious flange rubbing, or the crane will act similar to a crane with straight tread drivers of unequal diameter.

Best results are obtained where the wheel loading is reasonably uniform. Results are not as good where heavy loads are frequently carried on one end of the bridge or where a heavy operator and control cab is mounted at one end of the crane. Poor dead weight distribution will give shorter wheel life on any lineshaft type crane and this point should receive consideration where possible.

Third, consider the combination of straight tread double flanged wheels without cross-shaft (Figure 3) and with separate motor drives on each end. Since 1945 we have put several hundred overhead and gantry cranes in successful operation with this combination. Less shafting, gearing and bearings are needed with separate d-c motors in series. Bevel gearing is eliminated on gantry cranes reducing maintenance. There has been widespread acceptance of separate motor drives on gantry cranes but much reluctance to using the same idea on overhead cranes. Driver wheel diameters need not be held to accurate diameters. It is not necessary to replace both drivers at the same time.

With a lineshaft drive any inequality of wheel travel distance will eventually cause wheel slippage and flange rubbing. To slip one wheel there must be a torque developed equal to the load on that wheel times the coefficient of friction on the rail. The point here is that no condition of flange contact with separate motors can be as severe as the condition of self-driven jamming shown in Figure 1.

With separate motor drive no torque differential would normally occur. The most which could occur would be that of one motor acting alone which tests on long span cranes in service prove can drive a long span crane without wheel slippage.

For direct current, the most simple drive arrangement of the motors and control is to connect series motors in series and use a standard single motor controller. In our experience for indoor service with this arrangement both motors will deliver equal torque to the driving wheels with no slippage.

A controller with a special feature is being processed for patent protection. This control is used for outside service or for indoor wet rail conditions. If one wheel slips the control is arranged to increase torque on the wheel which has traction and decrease torque on the slipping wheel until traction is restored at which time this control feature will drop out automatically. Several cranes are now in service with this control on outside runways with no traction problem on wet or iced rails.

Series-connected motors run at half speed, require half the gear ratio otherwise needed, usually only one gear reduction at each end, and result in reduced maintenance of motors, brakes and control. A standard duplex parallel bridge control can be used with a saving in motors operating at line voltage but with the extra cost of the duplex controller and greater gear ratio required.

With alternating current, a synchrolock type of tie system cannot be depended upon to keep two motors in exact synchronism. The apparatus required would be complex and expensive for a heavy crane. Synchronism would be defeated by wide variations in load distribution, acceleration, mechanical braking, unequal wheel wear, etc. If it were possible to obtain rigid electrical synchronizing of separate drives with simple and dependable electrical equipment, the system would be subject to the same inherent defects and would be subject to the same wheel alinement problems as the crane with a mechanical tie shaft system. Wound rotor motors will adjust for any unequal wheel diameters by slight variations in slip. Standard control is used having separate sets of contactors to simultaneously commutate the secondary resistors for each motor.

With the recent interest in a-c equipment for mill cranes and the low cost of a-c motors compared to d-c mill motors, the use of separate motor drive should be even more attractive.

This combination of straight tread wheel and separate motor drive (Figure 4) is an outgrowth of a study of the results caused by the crane or runway being out of span. In case "A" (Figure 4) the outer flanges are not shown. This is the effect obtained if the runway span is less

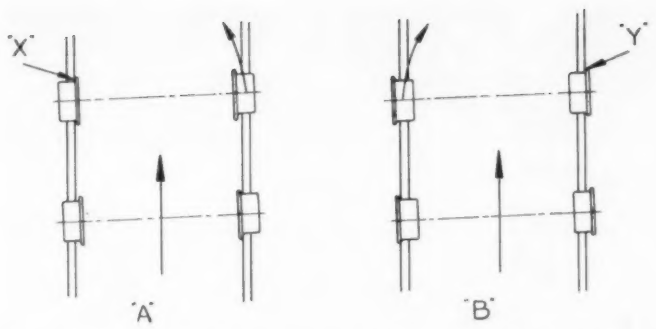


Figure 4 — If a track gage could be maintained it would be desirable to eliminate either the outside or the inside flange.

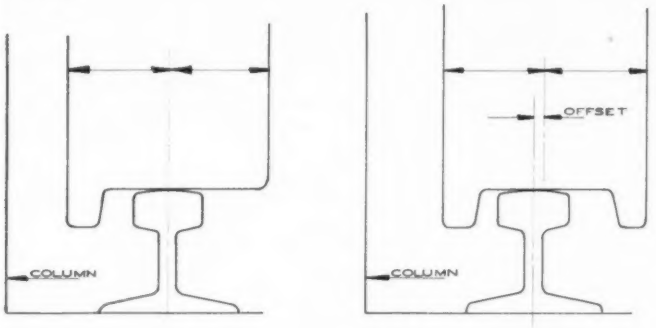


Figure 5 — An offset tread could be substituted for a regular double flange wheel.

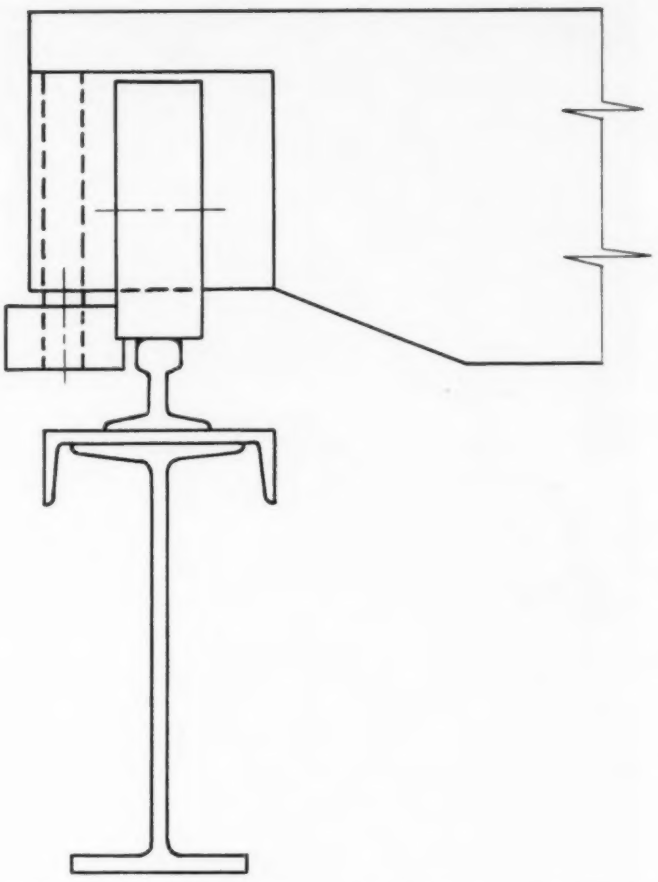


Figure 6 — A horizontal wheel to guide the crane has been used on some installations.

than the crane span on a crane having double flange wheels. With the crane traveling in the direction shown by the arrow, the lagging end strikes at "X" and the other end being free to continue tends to aggravate the binding.

In Case "B" (Figure 4) the inner flanges are now shown. This is the effect obtained if the runway span is more than the crane span on a crane having double flange wheels. With the crane traveling in the direction shown by the arrow, the leading end strikes at "Y" and the other end being free to continue tends to free the binding and square the crane.

These effects are the same for travel in either direction.

In Case "A" the inside flanges do all the squaring with excessive wheel flange and rail wear. In Case "B" the outside flanges do all the work of alinement with comparatively little wear. If wheels with outside flanges only are used, regardless of runway span variations, the "B" condition in Figure 4 would always be obtained.

Most users would be hesitant to depart from the conventional double flanged wheel so the offset tread on Figure 5 can be substituted, making the outside flange heavier than the inside flange.

We have started proceedings to obtain patent protection for the combination of separate or differential drive on each end with single outside flanged wheel or wheels with double flanges having the tread intentionally offset so that only the outside flanges will contact the rail for squaring.

We have demonstrated with models and recent installations that a crane built this way will negotiate a curved or S-shaped runway of large radius.

The full benefits of single outside flanged wheels will not be realized unless the crane is built with individual motor drive on each end with no lineshaft—giving the crane complete freedom to square up upon flange contact. The above explains why otherwise identical cranes on the same or different runways can give entirely different results with or without a lineshaft.

Some years ago we considered the use of two sets of flat tread flangeless wheels one set carrying the load and the other guiding on the inside of the rail head. See Figure 6. This has limited possibilities because of variety of rail shapes. Separate vertical and horizontal rails would be better but expensive. Results the same as with outside flanges only could be obtained if the guide rollers of the above combination were mounted to guide on the outside of the rail head. This alternate construction is also noted in our patent proceedings.

SUMMARY

Model tests and incomplete field tests indicate that the combination of separate end drive and single outside flanged wheels or equivalent to be the answer to overhead crane wheel problems.

A lineshaft cannot properly be called a squaring shaft because it does not do any squaring, since a lineshaft can only—in proportion to its stiffness, maintain the equal rpm of the drivers on each end—regardless of the position the crane occupies on the runway.

The structure of any overhead crane or gantry with the exception of long span skewing types, whether it be designed with a mechanical tie shaft system or separate drives must be sufficiently rigid to maintain squareness of the crane itself. A lineshaft is not a substitute. ▲

Figure 1 — Heavy loads and hard service feature steel mill crane operations.

The Selection of Crane Wheels

by ROSS B. McCREADY, Director of Engineering, Alliance Machine Co., Alliance, Ohio

Crane wheels should not be casually selected . . . what may appear to be a right solution may only aggravate wheel conditions

TABLE 29-1

Diameter of wheel, in.	Rail Section							
	ASCE 60 lb		104–105 lb		135–136 lb		171–175 lb	
	Allowable load, lb	K	Allowable load, lb	K	Allowable load, lb	K	Allowable load, lb	K
12	28,000	982	...	...	...	...	...	...
15	35,000	982	...	...	...	...	...	...
18	42,000	982	50,000	1110	...	...	...	...
21	49,000	982	59,000	1123	...	...	...	...
24	56,000	982	67,000	1116	89,000	1235	...	...
27	...	...	73,000	1082	95,000	1173	128,000	1185
30	...	...	76,000	1013	102,000	1134	135,000	1124
36	...	...	79,000	877	109,000	1010	142,000	986

THERE are four general classes of crane wheel materials being used in steel mills today:

1. Untreated rolled steel.
2. Rolled steel toughened rim.
3. Carburized steel.
4. Chilled iron, alloy iron, etc.

The untreated rolled steel wheel has a Brinell hardness of about 262. The toughened rim wheel has a Brinell hardness of 321 minimum at the tread surface. The carburized wheel may run as high as 700 Brinell and may be drawn back to hardnesses as low as 400 Brinell. The iron wheel will not be discussed in this paper since there are very few being used on production cranes in steel mills.

The advantages of using tapered tread or straight tread bridge wheels will be dismissed with but one observation. We have replaced straight tread wheels with tapered tread wheels and solved bridge wheel problems. We have never seen this work in reverse.

Table 29-1 in the 1949 AISE Crane Specification No. 6 lists the allowable wheel loads for various diameter wheels running on various rail sections. These ratings are for untreated rolled steel wheels.

For the last eight years, our design department has been using ratings 27 per cent in excess of those listed in this table when applying rolled steel toughened rim wheels. This increase is based on data received from one of the manufacturers of rolled steel wheels in 1952.

The untreated rolled steel wheel has little reason to be used on cranes today. The toughened rim wheel yields reduced crane costs. Such wheels have an increased capacity of 27 per cent at a cost increase of only 5 per cent. Toughened rim wheels also offer the user a bonus of longer wear over untreated wheels.

The carburized wheel, we feel, should be rated close in capacity to that of the untreated rolled steel wheel. We have found that carburized wheels under loadings permitted for toughened rim wheels have broken down within a matter of weeks. This defect may be avoided by the use of a stronger core and drawing back the rim hardness to prevent spalling or cracking under relatively heavy load and impact. The resultant wheel then approaches rim toughened wheel characteristics; that is, a more gradual decrease in hardness from the rim to the core.

In many cases, we have had to replace carburized wheels with rim toughened wheels within a few weeks. The rim toughened wheels then lasted five to twelve years and possibly longer. We have had this experience at a number of steel plants.

The advantage to be gained in using a carburized wheel is the longer life it will give—provided the loading is not excessive and the runway conditions affecting impact are reasonable. This then is the place for an item that costs perhaps 100 per cent more than an untreated rolled steel wheel and which may last 400 per cent longer. We have had successful experience with carburized wheels under these conditions.

This information is based on actual experience and field data.

Table I of this paper shows Table 29-1 of the AISE Crane Specifications with some additional data. The left hand column lists wheel diameters, and across the top are listed various rail sections. The table then gives, for example, an allowable wheel load of 89,000 lb for a 24-in. wheel on a 135-lb rail.

The popular formula in use today for calculating allowable wheel loads is based on the general Hertz formula

$$P^2_{max} = \frac{0.35\ P_0 E}{L d_r}$$

$$P_0 = \frac{(P^2_{max}\ L d_r}{(0.35\ E)}$$

$$P_0 = K L d_r$$

where:

P_{max} = max stress, psi
P_0 = load in lb
E = modulus of elasticity in psi = 30,000,000 psi for steel
L = roller length in in.
d_r = roller diameter in in.

The problem in using this formula is what value to use for K, and whether K should decrease as the wheel diameter increases. There is little information in the texts on this subject. In this table, the K values are listed beside each loading. There is a maximum variation in these values of about ± 10 per cent except for one value. Note the constant 982 value for K for all wheels on the 60-lb rail section and the changing values for all other rail sections. These K values range from a low of 877 to a high of 1235. No changes are suggested for this table, since we have no conflicting or supporting test data. We should keep what we are presently using until the time there is test data, and developing such test data would be a real contribution on the part of the AISE.

We do suggest that as an adjunct to the present table that toughened rim wheel ratings 27 per cent in excess of those shown in the Table 29-1 be used. This change is based on experience and field data obtained over a period of many years as well as information from a manufacturer of rolled steel wheels.

Rails over 91 lb are listed as being heat treated to 321 to 388 Brinell hardness. They will not be softer than toughened rim wheels. A look to the future suggests also that we will be needing heavier rails with wider heads for as capacities have increased, we are getting to the place where the largest crane rails, 171 to 175 lb are not providing the heavy crane builder with enough head width to keep the total number of wheels down to an economic number. As a result, the number of equalizer trucks, yokes and all the bearings, pins and axles that go with them, tend to pyramid the cost. Head room also suffers. We hope to see a rail of somewhere between 250 and 300 lb available in the future with a head width of between 5½ and 6 in. These, naturally, would be used for heavy wheel load installations.

In closing, it does seem a shame to give the problem of developing test data to the Association of Iron and Steel Engineers. However, who would be better qualified to conduct unbiased tests? ▲

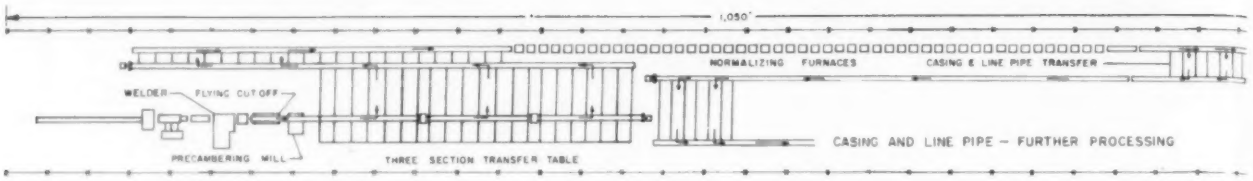


Figure 1 — Layout of Lone Star Steel's No. 2 electric weld pipe mill and strip mill facilities.

Lone Star Steel Co.'s New Stretch Reducing Mill

by LEONARD ELLER, Superintendent E. W. Pipe Mills, Lone Star Steel Co., Dallas, Texas

ON January 7, 1958, production was initiated on Lone Star Steel's stretch reducing mill; which, through its unique reduction process, permits the fabrication of tubing, and smaller size casing and line pipe from the company's No. 2 electric weld pipe mill product at tonnage rates equivalent to maximum welding mill speed.

Referring to Figure 1, pipe lengths up to 200 ft for stretch mill use are transferred by coupled, three-section chain conveyor tables, which may be used separately when producing regular 6⅝-in. outside diameter casing or line pipe lengths (maximum No. 2 welding mill nominal size).

The tube is then conveyed through a 48-barrel, 312-ft long normalizing furnace with exit temperature approximately 1650 F. Stretch mill product then proceeds through an additional 13 barrels of reheat furnace while 6⅝-in. casing or line pipe is transferred to cooling, sizing, straightening and finishing facilities.

The exit end of the reheat furnace is in close proximity to the entry stand of the mill proper with pipe entrance temperature approximately 1800 to 1850 F.

After outside diameter and wall reduction is accomplished, the tube is automatically sawed to desired lengths, which are kicked off onto a screw type cooling bed, where nominal lengths are transferred to further sizing, straightening and finishing functions.

Due to an end-thickening condition inherent to the stretching process, the first 3 to 6 ft of the first piece of reduced tubing is cropped automatically by the rotary flying saw.

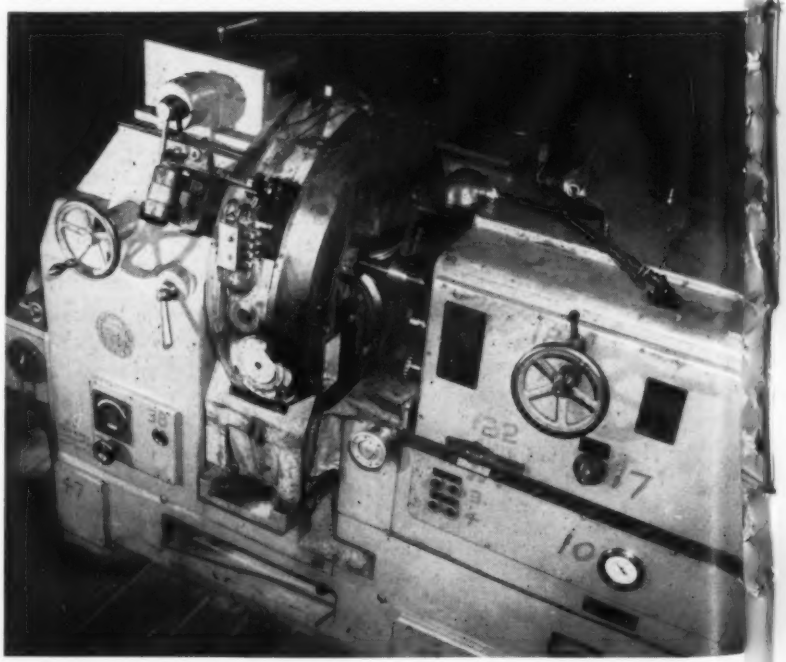
The last piece of reduced tube is automatically selected and conveyed to a tail end crop saw for elimination of the thickened end. This route is also taken by all sizes above 3½ in. outside diameter for further processing.

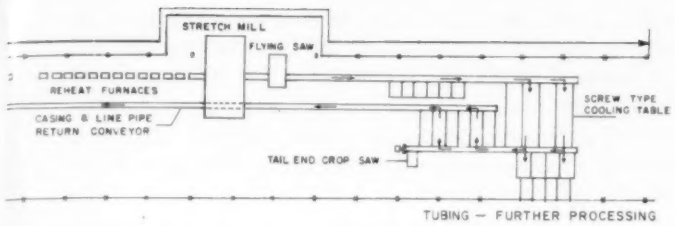
Lone Star's stretch reducing mill differs from the conventional design by the use of three rolls per stand instead of two. The mill was originally installed with 14 working stands with provisions for two additional stands. Preparation for the installation of these two stands is now in process due to a recent enlargement of maximum ingoing pipe size from 5⅝ to 6⅞ in.

The stand center lines are spaced 16 in. apart and each stand is rotated 60 degrees from the preceding stand. Theoretical roll diameter is 16 in. with speed range varying from 30 to 50 rpm ingoing, to 125 to 190 rpm at exit, for 14-stand operation.

Since diameter reductions exceeding the usually

Figure 2 — A special lathe is used to machine the rolls.





.... this new stretch mill at Lone Star Steel provides extreme flexibility of operation and increases output....

small values of sizing mills demand an "opening" of the circular roll, the rolls are machined by a tool, which cuts ahead of the roll center plane, except for the final sizing pass, which is cut with the tool positioned in the roll center plane.

For this purpose, the rolls remain mounted in each individual stand, and the latter is housed in a special lathe (Figure 2) equipped with a suitable roll drive and a tool carriage, to which carbide cutters are fitted.

The rolls of the stand are driven from a separate motor through a stepless mechanical speed adjustment.

The feed of the cutting tool is also adjustable through a stepless hydraulic drive. The rolls can be turned to a predetermined groove by presetting the feed final stop. After the rolls have been turned the desired amount, the feed is cut off automatically.

Cutting accurate roll grooves in this manner is necessary due to the elimination of roll adjustment in mill design.

To discuss the basic theoretical design formulae and calculation procedures for mill schedules would be rather unnecessary, since they are described in detail in an excellent paper entitled, "Considerations of the Theoretical Deformation in Reducing Mills and Their Roll Groove Calculation," co-authored by Messrs. D. Hancke and F. W. Neumann which has been available for some time.

Normal reduction schedules for roll contour and stand speed can be calculated in a few hours with assurance of an accurate end product.

The basic form of the roll pass is shown in Figure 3. The calculated theoretical roll pass diameter, determined by the tube diameter d_i, is replaced by a triangle constructed of elliptic arcs, with total circumferences $d_i \pi$. Figure 4 shows a section of Figure 3. The small semi-axis b_i of each roll pass is overlapped by the large semi-axis a_i of the consecutive roll pass to an amount dependent on diameter reduction.

Rolls are of chilled cast iron material with a hardness of 43 to 45 Rockwell C.

Roll wear properties have been excellent as exhibited by an initial run of 1,000,000 ft of 2⅜-in. tubing from 5⅝-in. ingoing tube before replacement of any stand in roll setup was found necessary.

The roll bodies are keyed into forged steel sleeves with hypoid bevel gear bodies at the drive end.

The sleeves turn on tapered roller bearings, which are seated on fixed arbors. The complete roll set is driven by a forged steel shaft, which carries the third roll and the two driver bevel gears. The drive shaft is also supported by tapered roller bearings. This arrangement results in only one shaft going into each stand, thus providing easy disengagement of the roll stands from the mill drive.

All bearings and labyrinth seals are continuously counterflow greased from a central motorized mill station, thus preventing the invasion of scale and water,

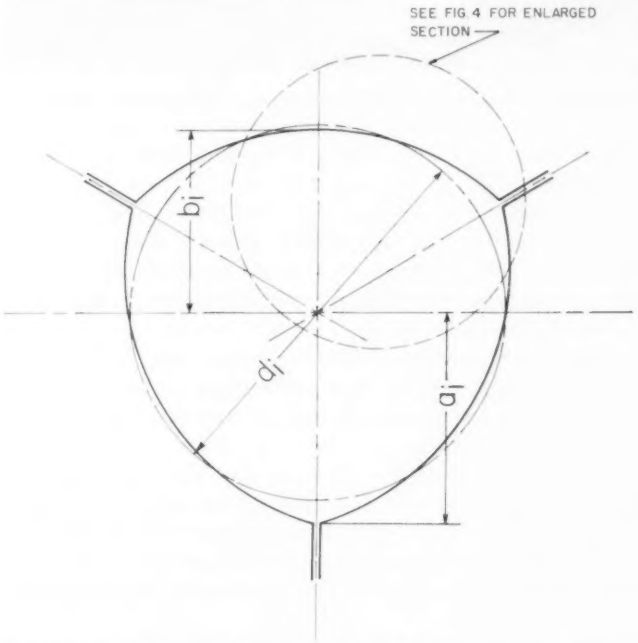
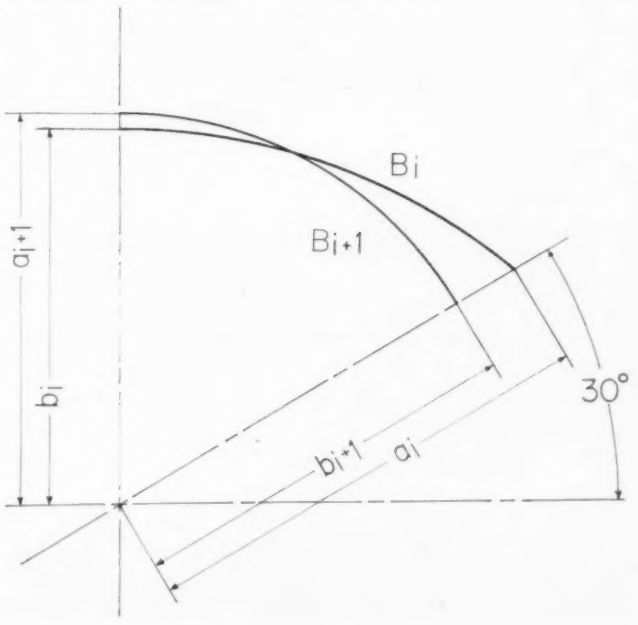


Figure 3 — Roll pass design for the 3-roll reducing mill.

Figure 4 — Enlarged section of Figure 3.



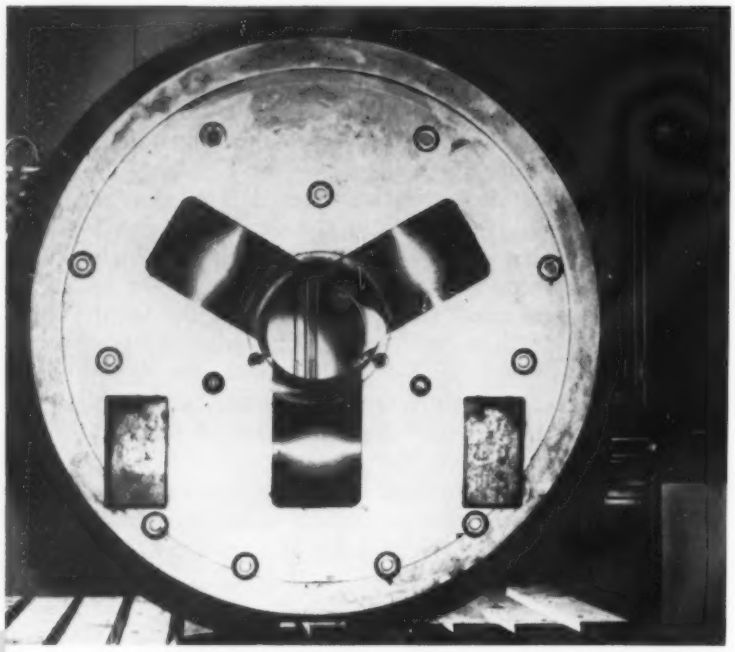


Figure 5 — Roll stand assemblies are circular in shape.

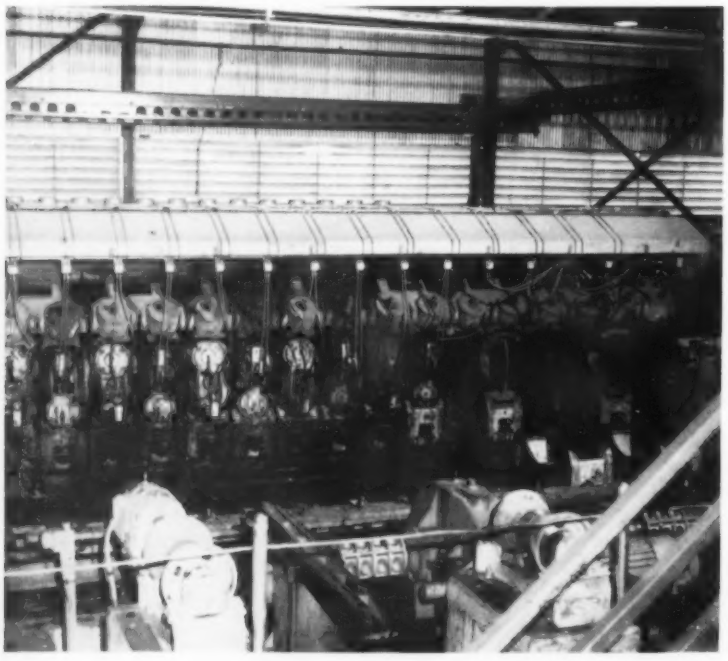
which is used as a cooling and flushing agent, into the roll assemblies.

The roll stand bodies are cast steel and circular shaped (Figure 5) so that they can be fitted to their saddles in two 180-degree reversed positions to provide for the necessary staggering of 60 degrees from one roll stand to the next.

The construction of the mill proper (Figure 6) is such that two special stand changing trucks are provided to assure quick change of stands for different reduction schedules.

The stand changing devices are designed so that any one, any group or all of the stands can be changed very quickly. The stand changing device moves the stands against a machined alinement block and the roll drive gear coupling is automatically engaged.

Figure 6 — Two special stand changing trucks provide quick changes for various reduction schedules.



Simultaneous clamping of stands in groups of three by a locking lever is actuated and held under pressure by an oil hydraulic cylinder above the roll stands.

Hoses for cooling water and grease systems are equipped with quick disconnect couplings to allow for attachment while the mill operator is setting up his speed schedule.

With a separate set of stands ready on the second stand changing truck, a complete new reduction schedule can be set up, including speed adjustment, in about 30 minutes.

The reducing stands are all connected to a common shaft powered by an 800-hp, 2300-v, a-c induction motor operating at a speed of 900 rpm. Between this main drive shaft and the individual rolls, there is for each roll stand a speed control device consisting of a differential gear and a speed change mechanism composed of a hydraulic pump and motor combination (Figure 7). The tilt of the hydraulic pump controls the speed of the hydraulic motor, which in turn, sets up the differential ratio in the planetary gear system used for the roll drive. Tilting of the hydraulic pumps is accomplished by a servo-motor on each pump unit. The servo-motor is connected so that it can operate as a wound-rotor motor when initially setting up each stand according to speed calculations, and as a synchro motor when all stand speeds are to be adjusted as a unit through a co-adjust circuit initiated from the operator's desk. When used as synchro motors, the servo-motors are fed from a transmitter driven by a variable speed d-c motor, which in turn, derives its power from a motor-generator set. In co-adjusting, the synchro system acts as a shortlegged see-saw pivoting on synchro number four; the three previous synchros going successively slower or faster, while the following synchros go successively in the opposite direction, maintaining the same relations between rolls as previously set up, while at the same time changing the system speed.

Units are duplicated throughout the construction of the mill. Each stand has four separate components; the stand bevel gear unit, the hydraulic drive, the differential drive and the stand speed reduction unit. All of these units are interchangeable for any of the stands, with the exception of the gearing in the stand speed reduction unit.

A tachometer-generator on each stand feeds a meter calibrated in fpm, located on the operator's desk, and also supplies other meters located conveniently to the operator, which show the percentage of speed differential between successive rolls (Figure 8). These meters are used in the initial setup of mill speeds. There is also a tachometer-generator located at the front end of the mill, which registers on a meter the difference in speed between pipe entering and leaving the mill.

After leaving the stretch reducing mill the pipe travels under a photo-electric cell, infrared sensitive, which through a relay, sets up the electronically controlled saw to make the front end crop cut. Almost immediately after appearing under the photo cell, the pipe makes contact with the measuring wheel, which because of its pressure on the pipe, now rolls at the same speed as the pipe itself. The wheel drives a tachometer-generator, that conveys a pipe speed signal

to the electronic control circuit of the saw, in order that the saw in making the cut will travel in its arc at a speed of one to three per cent faster than the pipe.

When the measuring wheel is not in contact with pipe, it and the tachometer-generator is turned by a variable speed d-c motor through a clutch device so the wheel can be rotating at approximately pipe speed at the time the pipe appears under the wheel. The motor is declutched from the wheel by a second set of contacts on the photo-electric relay, under which the pipe passes when leaving the stretch mill.

The saw blade for cutting the pipe is mounted at right angles to pipe travel on a carriage brought into cutting position by two radial arms, which swing in a 360-degree circle in the direction of pipe travel (Figure 9). The saw blade of 26 in. diameter is driven by a 440-v, a-c induction motor of 10 hp, traveling at about 3500 rpm. The saw carriage is rotated through a gear train by two 50-hp, 230-v, fan-cooled, d-c motors, mounted in tandem. Power for the d-c motors is derived from a 100-kw, 240-v rectifier assembly, built up from sealed ignitron mercury arc tubes and its component firing tubes, operating from a 440-v, 3-phase power supply. This assembly is essentially the same as any electronic welding power unit. However, in this case there are two banks of ignitrons of six tubes each; one bank being used to accelerate the tandem motors from the rest position near top center to the cutting position in the path of the moving pipe; the other bank being used to decelerate the travel upward in the 360-degree arc so that the saw carriage will come to rest again near top center in readiness for the next cut. The speed of the saw carriage in traveling its complete revolution is determined by the output voltage of the measuring roll tachometer-generator being fed into a voltage regulator, electronically controlled, which is made a part of the saw carriage power supply. The ignitrons are cooled by a closed loop water circulating system. The heated coolant is in turn cooled by a constant fresh supply of water flowing through a heat exchanger.

After the front crop is cut from the pipe, the front end of the first desired length of pipe passes under a second photo-electric cell, which sends a signal to the saw carriage control panel to make the cut at the proper instant. The second photo cell is mounted on a track so that it can be adjusted to cut lengths from 20 to 45 feet. In addition to this major adjustment for lengths, there is a vernier located on the desk for fine adjustments within about six feet. Actually, this cut and the following regular cuts are made with the first and second photo cells working in conjunction. Length tolerance at maximum speed, regardless of pipe length, is plus or minus $\frac{1}{4}$ in. If the last piece of reduced tube has passed from under the first cell before the second photo cell has had time to complete its cut signal to the saw carriage panel, the cut circuit will be opened and the saw carriage will allow the pipe to continue to the sorting area for further processing. In order to avoid excessively short tail crop cuts, the length of the tail crop, or rather the length of the last piece in the run of pipe, is determined by a potentiometer located on the operator's desk.

The saw exit conveyor is set for a faster speed than the saw travel or the preceding conveyor. Thus, when

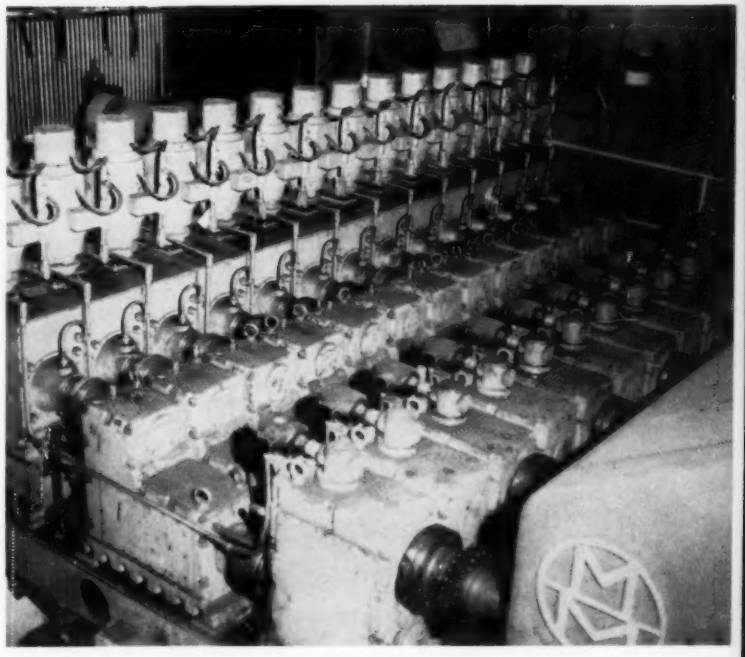
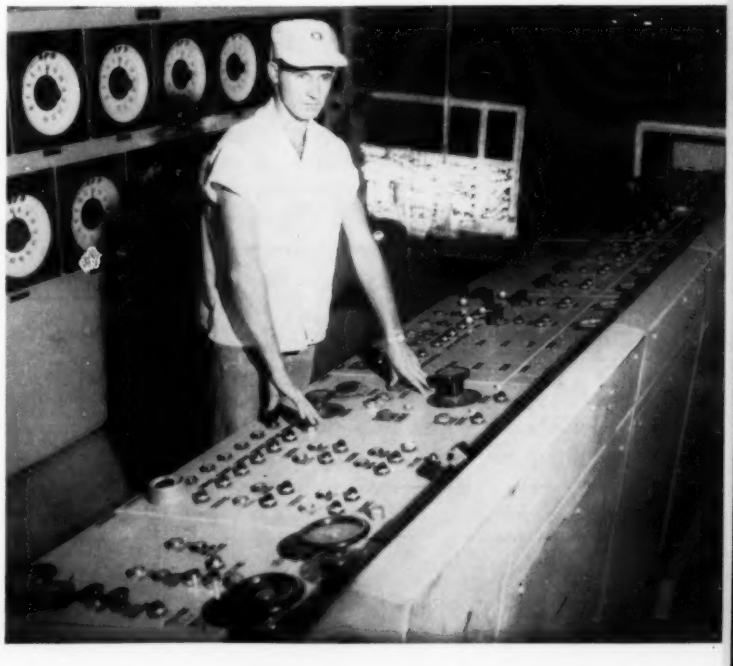


Figure 7 — Hydraulic drives and differential gearing mechanism are used for speed control.

the front crop leaves the saw it gradually widens the gap between it and the front end of the following pipe, as do all the following tubes. The front crop end drops into the crop pit. The front end of the first regular-cut length of pipe spans the opening of the crop pit and passes under a third photo cell, which de-energizes the circuit to the solenoids that hold the front end crop pit gate open pneumatically. The front crop pit gate closes and all following pipe in this run travels on the motor powered rolls, which are a part of the gate.

When the pipe passes under the third photo cell, a second set of contacts in the photo relay sets up a pipe length measuring circuit, which in conjunction with a fourth photo cell, will kick out any under-length

Figure 8 — Convenient meters in the pulpit aid the operator.



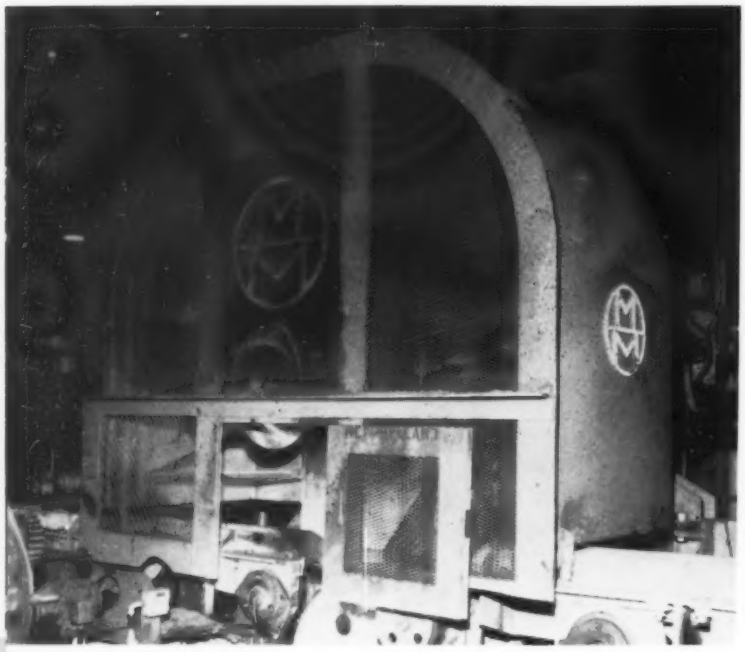


Figure 9 — The saw blade is 26-in. in diameter and driven by a 10-hp motor.

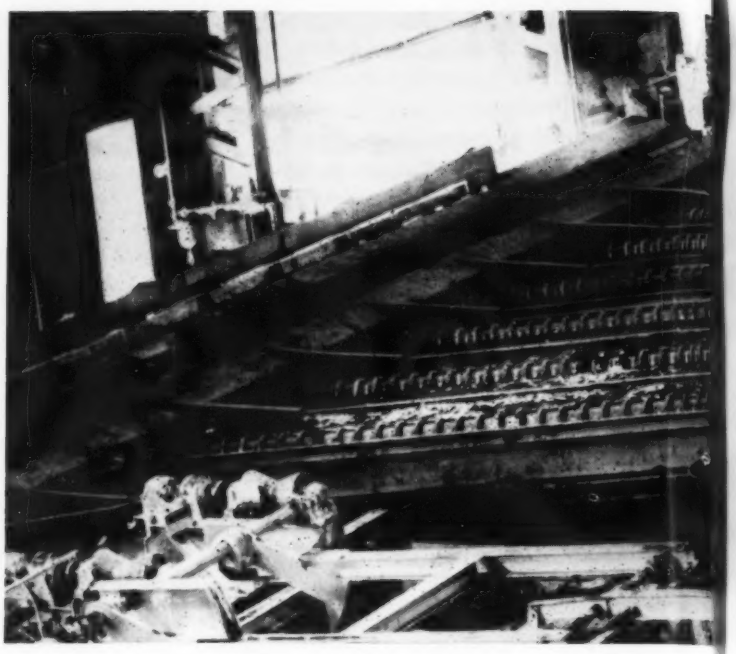


Figure 10 — The kickoff is operated pneumatically and the conveyor electrically.

pipe to a cradle for separate disposition. This conveyor is operated at a faster speed than the saw outlet conveyor to provide further separation between cut lengths.

All regular cut lengths and the longer lengths are kicked out onto the screw type cooling bed (Figure 10) by a system of wiper rolls, that are actually a combination conveyor and kickout; the kickout operated pneumatically and the conveyor operated electrically. The kickout is initiated by the tail end of the pipe passing from under a fifth photo-electric cell, with the actual kickout time determined by the operator manipulating a rheostat on his desk to provide time delay. The kickout section is made up of almost horizontal flat rolls and a group of vertically mounted wiper rolls. At rest, the wiper rolls are in the "out" position so the pipe will roll onto them and be carried farther forward on its radial surface. As soon as the kickout time delay expires, a solenoid is energized, which retracts the wiper rolls and wipes the pipe off, with the aid of a back-stop, onto the flat rolls. In the full retract position a limit switch is actuated, which de-energizes the retract solenoid and energizes another solenoid momentarily to operate air valves to bring the wiper rolls forward again and at the same time wipe the pipe from the horizontal rolls onto the screw cooling table.

The threads of the screw table are so arranged that the pipe is fed over against a flat guide bar so that one end of all the pipe on the table is in alinement. As the pipe approaches the end of the table on its way to the finishing area, the pipe strikes a set of limit switches which sort the pipe for length. At the end of this screw table there is another conveyor leading to the tail end crop saw section. Over this last conveyor there is a set of movable arms, which will either bridge the conveyor when down or act as an open gate for pipe to the conveyor when up. If pipe moving across the screw conveyor strikes two of the limit switches, the arms will stay down and the pipe will fall by gravity to the second cooling bed, which carries it over to the sizing mill and beyond. If only one, three or four

TABLE I
Stretch Reducing Mill Schedules

Ingoing outside diam, in.	Ingoing gage, in.	No. of stands	Max. elongation, per cent	Exit outside diam, in.	Exit gage, in.	Exit speed, fpm
Accomplished						
5⅝	0.188	13	3.16	2⅜	0.154	445
5⅝	0.244	13	3.16	2⅜	0.190	440
5⅝	0.275	13	3.04	2⅜	0.218	462
5⅝	0.156	7	1.23	4½	0.156	183
5⅝	0.188	7	1.23	4½	0.188	183
5⅝	0.205	7	1.23	4½	0.205	183
5⅝	0.250	7	1.23	4½	0.250	183
6⅞	0.215	10	1.64	4½	0.205	254
Contemplated for Future Production						
6⅞	0.220	16	5.25	1.900	0.156	675 (approx.)
6⅞	0.265	16	4.38	2⅜	0.190	586 (approx.)
6⅞	0.244	13	3.75	2⅞	0.217	540 (approx.)
6⅞	0.244	6	1.20	5½	0.244	172 (approx.)

limit switches are struck by the pipe, the arms will open to drop off into the conveyor leading to the tail crop saw.

Operating personnel for the stretch mill area has been limited by the extensive amount of automatic control built into the control and handling functions.

Speed setup, co-adjustment, mill controls, conveyors to wiper kickout and rotary flying saw controls are handled by the stretch mill operator, located in the elevated stretch mill pulpit (Figure 8).

Controls for kickout to screw bed, tail end crop saw, inlet conveyor to crop saw and transfer table to casing and line pipe conveyor are handled by the crop saw operator, located at floor level.

One laborer, who assists in size changes and in maintaining material flow, executes necessary crane lift hook-ups, and performs miscellaneous burning, completes the stretch mill crew of three men.

Table I indicates the reduction schedules that have been accomplished thus far. Included also, are those schedules which are contemplated for future production.

The addition of stands No. 15 and No. 16, and the already enlarged range of 6⅞-in. actual ingoing pipe size will further enhance the tonnage and reduction potentials of the mill.

Each day of stretch mill operation at Lone Star Steel Company results in added realization of the tremendous flexibility of this process when coupled with an efficient electric welding mill line production.

Discussion

PRESENTED BY

DIETER HANCKE, Vice President-Sales, Mannesmann-Meer Inc., Youngstown, Ohio

LEONARD ELLER, Superintendent, E. W. Pipe Mills, Lone Star Steel Co., Dallas, Texas

S. J. ROUMANIS, Metal Rolling and Processing Engineering, Industrial Engineering Section, General Electric Co., Schenectady, N. Y.

CHARLES A. TURNER, Chief Metallurgist, Selas Corp. of America, Dresher, Pa.

C. W. THOMAS, Assistant Sales Manager, McKay Machine Co., Youngstown, Ohio

J. H. GREENBERG, Assistant to President, A. J. Boynton & Co., Chicago, Ill.

LOUIS MOSES, Mill Engineer, Bethlehem Steel Co., Bethlehem, Pa.

JOSEPH P. WADLECK, Development Engineer, Aetna-Standard Div., Blaw-Knox Co., Elwood City, Pa.

Dieter Hancke: I would like to ask three questions:

1. We understand that there was practically no maintenance on the hydraulic units of the stretch mill drives. Would you make a comment on this?

2. What's the production capacity of this combination of welder-stretch reducing mill in tons per hour, say for production of 2⅜-in. tubing from 6⅝-in. pipe?

3. You stated that you have had a run of 1,000,000 feet of tubing in one instance before you had to remove the sizing stands of the mill. Since all stands are rotated through the mill, that is they go in with the smallest pass diameter and gradually are remachined to the largest pass diameter, and since the mill has 14 stands, one could presume that about 12 passes would come out of a set of rolls provided you always use the same roll pass setup and do not shift to another pass series. That then would mean that at least 12,000,000 feet could be rolled with one set of rolls. I would like to have you comment on that.

Leonard Eller: With regard to maintenance on the hydraulic units of the stretch mill drives, it has been at the very minimum thus far.

In answer to your second question here, I would say as a rough guess that the tonnage potential of 6⅝, 0.265-in. gage, to 2⅜-in. tubing would amount to about 65 or 70 tons per hr.

In answer to your third question, the only basis we have for determining roll life so far was that initial run of 2⅜-in. tubing. We have run a number of different combinations since, but in most cases we have used rolls from one combination into another, which would certainly not justify any measurement of roll life.

At this time I cannot give you any idea of the roll life of 5⅝ to 4½ or 5⅝ to 2⅞-in. or of other combinations. However, we were very well pleased with the roll life we realized on the initial run. It was well above our expectations.

S. J. Roumanis: Of particular interest to this discusser is the system used for driving and controlling the flying hot saw. In his description of this drive equipment, Mr. Eller states that the rectifier is "essentially the same as any electronic welding power unit." The advantages realized in new drive systems are often obscured by complex and rigorous descriptions of their characteristics and capabilities. The rectifiers used to power this drive are considerably more advanced than any electronic welding power unit. However, Mr. Eller's use of the simile in this case clearly illustrates that although the drive system developed for this saw carriage is novel and new, the system consists of a combination of previously developed and accepted components.

The power supply for this saw carriage drive actually consists of two three-phase, full wave rectifiers connected back to back. This is the first time such a rectifier circuit configuration has been applied to a steel mill drive in the United States. Those who have worked on designing systems for controlling high speed flying saws and shears are familiar with the problems encountered in accelerating the inertia of the system and synchronizing the cutting device with the line speed without exceeding the commutation and heating limits of the drive motors and generators. The application of back to back rectifiers instead of a generator, eliminates from the system the time of response of the generator power supply to regulating signals.

The elimination of the power supply time of response from the drive system on this hot saw carriage drive makes it possible to achieve the following performance characteristics:

1. The drive can be accelerated and decelerated in a minimum possible time.

2. The maximum motor armature current and the rate of rise of armature current can be controlled accurately. Accurate control of these factors makes it

possible to meet the rigid cutting duty cycle without exceeding the capabilities of the drive motors.

3. The control system can be stabilized at a higher frequency and with a higher system gain than heretofore possible. These characteristics improve the accuracy with which the saw carriage drive is speed regulated to match the pipe speed at the time of cut.

4. This high performance system is more easily adaptable to operate in conjunction with a position regulator. This regulator receives its position signal from a selsyn and locates and maintains the saw carriage at or near "top dead center" during the "stop" portion of the cutting cycle. The use of the position regulator makes it unnecessary to set the mechanical brake when the saw is stopped. Therefore, the brake on this drive is set only in case of emergency or when the equipment is shut down.

The use of a reversing rectifier to power this drive has made possible the design of a system to meet a rigorous duty cycle. The methods formerly used for driving and controlling such drives would have resulted in limiting the top output of the mill.

Charles A. Turner: In his closing remarks Mr. Eller refers to the tremendous flexibility of the process when coupled with efficient electric welding mill line production. Our company is proud to be identified with this line in providing automated heating which matches the inherent flexibility of both the welding operation and the stretch mill.

When the No. 2 electric-weld pipe mill went into initial production the furnace line consisted of 33 barrel chambers, designed to permit normalizing production rate to keep pace with maximum mill output. Line speed was 50 to 150 fpm. To meet requirements of increased production and to accommodate the new stretch-reducing mill, a total of 27 additional barrels were added to the line. The present 60 barrel furnaces are arranged in a single straight line in two groups of 47 and 13 barrels. The first 47 chambers are utilized for normalizing when producing the larger size pipe. In this case the pipe is kicked off the heating line of the 13 reheat furnaces for transfer to the cooling table. When the pipe is to be stretch-reduced the full furnace line is utilized for heating to a temperature in the range 1800 to 1850 F. These additional furnace barrels were added without upsetting the basic scheme of the mill layout, while minimizing floor space for heating equipment to serve the dual requirements for normalizing or stretch-reducing.

Mr. Eller has very ably described a unique mill. Its outstanding performance in producing a tubular product of uniform outside diameter and wall thickness depends upon uniform heating and uniform rolling. The barrel-type furnace line feeds the mill with a heated pipe which is uniform in temperature over its full surface, from end-to-end, and from piece-to-piece. This is accomplished on 200-ft lengths of pipe at speeds co-ordinated with the stretch-reducing mill.

C. W. Thomas: It appears to me that there is an alternate possible arrangement of this equipment which I should like to question. In the resistance welding field we have attempted to produce equipment which is continuous in operating nature, and I question very sincerely why you cut this pipe into 200-ft lengths and then indicate that you have a scrap length of 3 to 6 ft for each individual piece handled.

Why do you not make this process continuous and cut off pipe after the stretch-reducing mill?

Leonard Eller: In answer to that, the original layout of our mill was such that we had to transfer from the welding mill line to get to the furnace line. It would be a tremendous expense to change that situation, and we feel that the amount of yield loss on 200-ft lengths as against what we might get out of a full coil length would not justify that expense at this time.

Furthermore, there are some most important problems in running straight through. We believe it much more efficient to keep a certain amount of surge in our welding operation to compensate for what stretch mill delay time we might have.

C. W. Thomas: By surge, do you mean that you may have a stockpile of pipe ahead of the stretch-reducing mill?

Leonard Eller: Yes. The tables which transfer the long lengths or short lengths, for that matter, can be filled with three coils while we are experiencing delay further along the line.

J. H. Greenberg: We have been making some more recent layouts of mills in which we have actually done what you talked about, and I think that if the mill is planned that way from the very beginning, that certainly can be made a process.

However, a straight line arrangement of welding line, furnace and stretch mill has certain obvious disadvantages, particularly in the event of a sudden shutdown of any of the components in the line. For that reason, we have preferred to use an offset arrangement similar to that used at Lone Star.

Louis Moses: Do three rolls exert more pull than the conventional two roll construction?

J. H. Greenberg: Three-roll is supposed to have much better characteristics in that direction.

Dieter Hancke: There are two questions involved here:

The first question deals with the opening of the roll pass as such. Now, in reducing pipe one always has to open the pass, because if one does not do so one will get the material into the roll gap. So this is a necessity regardless whether one has a two-roll or a three-roll mill.

The second question concerns the difference in slippage which would express itself in, I would say, inefficiency of the roll pass. In the past we have built quite a number of two-roll mills, and with experience from these and from the new three-roll mills, it is known that the deformation efficiency of the three-roll pass is about 15 per cent higher than that of the two-roll pass.

Joseph P. Wadleck: I wish to contribute to discussion on "slip" and power requirements in 2- versus 3-roll mills.

In the roll passes of both 2- and 3-roll stretch mills, there is only one roll radius at best, i.e., two single lines of contact per roll at which the delivery speed of tube and roll are the same. At greater wall reductions calling for higher overspeeds between stands, in both 2- and 3-roll stretch mills, the equivalent roll radius corresponding to the linear speed of the tube may drop under the bottom of roll grooves. In either case for both 2- or 3-roll mills, we should rule out the thought

of "no-slip" and rely on kinetic friction.

From standpoint of diametral reduction in 2-roll mills, 10 per cent reduction per stand are quite common, and reductions considerably above these are successfully employed.

Wall reductions, aside from tube chemistry, tube temperature will depend on:

1. Contact area between tube and roll, i.e., on D (mean roll diam), d (mean pass diam) and the draft or diametral reduction.
2. On the kinetic co-efficient of friction between roll and tube.
3. On t (tube wall thickness) and d/t.
4. On the overspeed between stands.

Mr. Hancke's reference to the total horsepower capacity of motors with 2- and 3-roll stretch mills to prove his contention for higher production efficiency with 3-roll stretch mills needs correction. The higher total motor horsepower capacity of the individual variable speed motors (for regulating overspeeds between stands) used on our 2-roll stretch mills has nothing to do with how many rolls the stand have, nor with the total rolling power consumed. It is due to shock loads as the front end of tube passes through the mill, and to load variation over the mill under different overspeeds between stands, to which the individual stands react. The actual power consumption for rolling, i.e., the horsepower per cubic in. per sec for 2- and 3-roll stretch mills according to all 3-roll mill-test data reaching us from England and Germany compared with the 2-roll stretch mill power data from our customers in U.S.A. and abroad show them for all practical purpose the same with perhaps in slight favor of 2-roll mills which very likely is accidental.

Dieter Hancke: The difference in grip between a two-roll pass and a three-roll pass is practically nil. I think I was misunderstood. I only said the deformation inefficiency, that is, the actual friction loss, is less in the three-roll pass than it is in the two-roll pass.

In order to answer Mr. Wadleck's question concerning practical experience, I would like to bring out one point without going too much into detail.

It is known that the stretch reducing mills of the two-roll type which are operated at various plants are making about the same reduction from 7 to 2⅜-in. in 16 stands. These mills have a total of 3200 hp installed, whereas the stretch reducing mill at Lone Star, which in effect operates with the same reductions, is driven by only an 800-hp motor.

I believe that serves to outline the difference in inefficiency of the deformation of the tube. ▲

Available Translations

As a service to readers of the *Iron and Steel Engineer* a list of translations from foreign articles is being printed intermittently. Articles selected for this listing will be those of primary interest to the American steel plant operator. The papers may be obtained from the British Iron and Steel Industry Translation Service, The Iron and Steel Institute, 4 Grosvenor Gardens, London, S.W. 1, England. All correspondence concerning price, ordering and so forth should be directed to that address.

1208 HEISCHKEIL, W., et. al: "New Plant in the Basic Converter and Open-hearth Steel Plants of an Integrated Iron and Steel Works," *Stahl u. Eisen*, 1959, Jan. 8, pp. 8–17. (Summary: Reconstruction at the August Thyssen-Hutte, Hamborn, to increase output by 50 per cent. Planning, erection and engineering data for the four fixed 250-ton furnaces. Flat hearths, one-ladle operation, pusher-type charging machines. Economic considerations. Comparison with other works. Notes on top-blowing.)

1247 EWERS, J.: "Olefine—and Benzole Formation in Coke Ovens," *Brennstoff-Chemie*, 1955, Feb. 9, pp. 33–37. (Abstract: A report of a lecture. Better yields of ethylene and benzene are obtained when mineral oil is injected into the gas space of the oven instead of mixing it with the coal. By choice of temperature and the length of stay in the reaction space either olefin or aromatics production can be favored. Time can be regulated either by control of throughput or by use of a carrier gas; longer times favor aromatics formation.) Also abstracted in *Chem. Abstr.*, 1955, col. 9260i.

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Considerations in

MANY reports have been given and considerable material has been published on the merits of different types of fire resistant fluids and the steps required to convert from one type of fluid to another.

It is not the writer's intention to present a full list of all the do's and don't's for each type of fluid available. However, an effort will be made to review some of the points of evaluation whereby the resultant fluid chosen may be expected to give satisfactory results in the specific location for which it was chosen. In trying to do this an effort will be made to use known adverse experiences for illustration.

The primary considerations which should be tabulated and then evaluated are:

1. The true need for a fire resistant fluid.
2. The toxic considerations from the standpoint of the type of fluid, and from the standpoint of air volume confinement at the place of use.
3. The degree of flame resulting from combustion of the fluid.
4. The amount of physical attention required to keep abreast of the condition of the fluid in use.
5. The type and solubility of surrounding atmospheric vapors or gases.
6. The desired system pressure.
7. The type of pump to be used.
8. The lubricity or wear characteristics of the fluid.
9. The maximum and minimum operating temperature.
10. The maximum and minimum expected ambient temperature.
11. The viscosity of the fluid for the full expected life temperature range.
12. The over-all economics involved.

In numerous instances two or more of the above items are interdependent and no simple answer can be given to their separation. However, let us examine them briefly in the sequence given.

When a fire occurs, the injury and suffering of employees, the loss of valuable production time and the damage resulting to equipment and products are the reasons for questioning whether a fire resistant fluid should be used. In some instances a different choice in auxiliary equipment or the installation of physical shields would remove the necessity of using a fire resistant fluid; in other cases, no amount of shielding or equipment change could remove the danger of fire and the use of a fire resistant fluid is required.

The toxic levels given in connection with the various fluids are relative. While irritations may be received from physical contact with them, the general consideration is with the variation of the vapor or decomposition products; which varies in accordance with the degree of concentration. The concentration, in turn, depends on the amount or volume of air present and the rate at which the air is moved or vented. While it is hard to believe in some circumstances, operators do subject themselves to fog and/or smoke clouds resulting from high temperature decomposition of liquids and some irritants are present in all of them. The principal considerations on this point are whether the fluid will support combustion in an atomized or in a liquid form, the amount of flame extending from the heat source, the amount of flame continuing after the heat source is removed, and whether the amount of movement of the air is great enough to remove the cloud resulting from the act of burning and to do it fast enough to prevent serious toxic effects on any individual who may have been injured or incapacitated as a result of the mishap.

By the use of a test similar to the hot manifold test, which might for steel mill use be called the hot slab test, the amount of flame which will result after spilling or throwing several ounces of a fluid on top of a red hot slab can be observed. This amount of flame can vary from one half inch or two inches for some of the phosphate ester type materials up to several feet for straight petroleum oil. The amount of flash burn to an individual near such a situation would be in proportion to the amount of flame and the resultant increased level of heat. No hydraulic fluid containing any hydrocarbons is strictly nonflammable or fireproof and the difference lies in the degree of fire resistance. In the case of water containing fluids, the water when vaporized as steam, acts as a diluent or shield for the oxygen present in the air which is needed for combustion. The relative amounts of flame in a decreasing order may be listed as follows: first, straight petroleum oils, in second and third positions which are close together are water in oil emulsions and water-glycol mixtures, and fourth the phosphate ester type materials. Phosphate ester base materials made up with one or more of the phosphate esters along with other possible hydrocarbon fluids will have flame in proportion to the amount of hydrocarbon with relation to the availability of oxygen for combustion.

The degree of physical attention to the conditions of the fluid in use and the type and solubility of surrounding atmospheric vapors and gaseous contaminants are the next items to be considered. Acidic gases and vapors, generally, are considerably more soluble in water than in either petroleum oils or phosphate ester materials. The amount of aeration taking place in some systems gives a very effective scrubbing action to the air volume involved. Acid vapors which may be present will be absorbed and corrosion can be expected. When a water containing fluid is used, this same aeration can increase the amount of water loss and bring about an increase in the flammability as well as a possible increase in viscosity. While all hydraulic systems should have a scheduled inspection setup, those which contain water should be of a frequent enough nature to prevent an increase in the fire hazard through the loss of water and to give information on the amount of residual alkalinity left in the fluid to safeguard against corrosion.

The expected system operating pressure along with the type of pump and the wear characteristics of the fluid should be evaluated together. By referring to

by C. T. LEWIS,
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Applying Fire Resistant Fluids

Many considerations must be carefully evaluated in selecting a fire resistant fluid and even in deciding whether a fire resistant fluid should be used . . . . important economies and safety are involved.

literature, provided by pump manufacturers, the operating pressures which can be obtained from centrifugal, radial, reciprocating or axial piston, vane and gear type pumps can be determined. Each type of pump has an optimum viscosity range wherein the most efficient operation can be obtained. At this point the wear characteristics of the fluid have a vital part in pump choice. The number of moving parts in the pump, the dependence of the pressure developing elements, and the internal pump bearing requirements for lubrication and heat dissipation. and the slippage characteristics of the pump can make or break an otherwise successful hydraulic system.

The over-all operating range of temperature would effect not only the viscosity requirements but also establishes the need for determining whether the maximum safe operating temperature is exceeded if a water containing fluid is contemplated. The maximum external temperature ranges present from furnaces or from steam tracer lines which could be expected to effect the stability of the fluid should be evaluated for all fluids.

The lowest expected ambient temperature must be provided for to prevent solidification or excessively high viscosity results.

The location of the fluid system reservoir with relation to other tanks or fluid lubricated or fluid consuming equipment may govern to some extent the choice of fire resistant fluid in order to either compensate or prevent mixing of fluids in use. Some installations in the past have been padlocked at the fill connection in order to prevent filling with the wrong fluid by an unauthorized person. The effects of mixed fluids can range from the loss of fire protection with no apparent visible change up to the formation of viscous jellies or heavy sludges.

When the economics of a fire resistant fluid installation are studied, the previous considerations are of extreme importance in addition to the base cost per gallon of the fluid. Fluid choice could affect the amount of ventilation and winter time heating costs of a building. The pump design and the number of repair parts and their replacement costs as a result of the wear characteristics of the fluid must be considered to keep costs at a minimum. The number of manhours required to be assured that the fluid in the system is satisfactory for further operation, both from the standpoint of its chemical nature and from the standpoint of its physical nature, add additional costs. Further costs may result if the chosen fluid requires protection from low ambient temperatures.

Consider for a few minutes, what means were used to solve some actual problems.

An oil-in-water emulsion was placed in a hydraulic system powered by a vane type pump which operated at a pressure of 1200 psi and at a temperature of from 100 to 110 F. As a result of the low viscosity and excessive slippage within the pump it was impossible to maintain the required pressure. The substitution of a reciprocating piston pump eliminated the problem.

Repeated failures of pump bearings were experienced with a vane type pump in a system filled with a water-glycol type of fluid operating at approximately 800 psi with a system temperature of 130 to 140 F. The bearings were an adaptation of a needle bearing using a center ridge on the inside of the outer race to guide the solid double length rollers. The outer race was supported for only a portion of its length under the outer race center rib. There was no provision made for fluid to flow through the bearing in order to carry away the heat generated by the rollers rubbing against the center rib. The concentration of load at the center ends of the rollers, combined with the heat build-up in the bearing, had an adverse effect on the water content of the fluid and the bearings failed. Changes in the pump bearing design to provide full bearing length load distribution on a sleeve bearing along with a small fluid flow through the bearing eliminated the problem.

Considerable aeration resulted through the use of a water-in-oil emulsion on a combustion control circuit. The system was located in a sulphur contaminated atmosphere and the fluid was not checked chemically at sufficient intervals to prevent acid build-up. As a result, tubing and other parts failed from corrosion. Most representatives of suppliers of water containing fluids will no longer recommend this type of fluid for installation in such atmospheres.

A phosphate ester fluid was used in an installation in which control lines were wrapped along with high temperature steam tracer lines through an outdoor location. Considerable sludge developed throughout the system and one of the control lines ruptured as a result of corrosion.

Laboratory checks on five different phosphate ester type fluids revealed that if as low as approximately one fifth of one per cent of water (which amount could enter a system as a result of condensation alone) were present along with steel surfaces, all five of the fluids would develop a sludge condition at 280 F in a few hundred hours and change in color ranging from a dark

brown to a black. Varying amounts of chemical reaction with the steel specimens in the tests were recorded. The conclusions to be drawn are: first, use all possible care in the storage, handling, transfer and use of phosphate ester materials to keep them dry and, second provide protection to prevent soaking at high external temperatures on semi-stagnant portions of a system.

In addition, the various other items normal to any hydraulic system such as valves, fittings, packing, seals, suction line leaks, system interior paints, strainers and filters should be reviewed since they, too, are affected by fire resistant fluids.

Discussion

PRESENTED BY

W. J. BROWN, Marketing Technology Service, Gulf Research & Development, Pittsburgh, Pa.

J. T. REA, Assistant Superintendent Mechanical Dept., Bethlehem Steel Co., Johnstown, Pa.

C. T. LEWIS, Chief Lubrication Engineer, Republic Steel Corp., Cleveland, Ohio

J. A. MATHE, Engineer, E. F. Houghton & Co., Philadelphia, Pa.

C. L. SEELBACH, Shell Oil Co., New York, N. Y.

A. E. CICHELLI, Lubrication Engineer, Construction Engineering Dept., Bethlehem Steel Co., Bethlehem, Pa.

W. J. Brown: Fire resistant fluids have done a remarkable job in decreasing the number of fire hazards confronting today's industry, and plant safety engineers have credited fire resistant fluids as being one of the most outstanding safety achievements in recent years.

However, with the increase in use of modern equipment utilizing fire resistant fluids, I would like to expound on Mr. Lewis' first primary consideration, the true need for fire resistant fluids.

One should be realistic about making such a decision and make a study of the economics involved. We all realize that every effort should be made to reduce the risk of human life or injury, but be sure the application is an unsafe practice and justifies the use of a fire resistant fluid.

The other considerations listed in Mr. Lewis' talk such as wear characteristics, pumps, physical attention and toxicity are all factors which must be considered before the choice is made.

This is not a simple decision to make. Most every hydraulic system on a blooming mill, a hot strip mill or a cold mill could be classified as a fire hazard, but where do we stop?

This question can only be answered by making a sound study of all the factors involved and definitely establish that a hazard does exist so that there will be no doubt the use will be justified in the end.

J. T. Rea: Mr. Lewis is to be complimented for presenting a very interesting paper on a timely subject. We agree that the hazards to personnel, possible loss of production and possible damage to equipment are the most important factors in deciding if it is necessary to use fire resistant fluids to reduce the fire hazard on any hydraulically operated unit. We consider these as essential demands, more important than any technical refinements in the fluids themselves.

We use a fire resistant fluid for operating a switch plate on our rod mill primarily for the protection of personnel near the furnace. Another fire resistant fluid is used for operating laying reels on the same mill primarily to avoid damage to equipment.

We have been using some water-oil emulsion type fluid for a considerable length of time without any serious problems in regard to operation and maintenance. We add a red dye to one of the water glycol type fluids, with the approval of the vendor, to facilitate the location of leaks. The water-oil emulsion type fluid has been improved by the vendor for a lower temperature operation than that originally supplied.

We are very interested in Mr. Lewis' comments in regard to the harmful effects of water even in very small quantities on the phosphate ester type of fluids. We have not used any of the phosphate ester type fluids, but we would consider them primarily for use on higher temperature applications. It would seem to us that there would normally be a considerable amount of condensation from which trouble might arise. We would like to ask Mr. Lewis, based on his findings in the laboratory and his experience in the field, what is the maximum continuous operating fluid temperature for satisfactory use of the phosphate ester type fluids?

C. T. Lewis: Our laboratory checks were made, as I mentioned, at 280 F primarily because that was the temperature that we believed did exist on the one installation where we had corrosion of the fluid lines.

A small amount of investigation at lower temperatures has been carried out, but no definite temperature limit has been determined. I believe that somewhere in the neighborhood of between 200 and 220 F would be acceptable.

I know we have several systems operating where the temperature varies anywhere from 150 up to 200 F, and so far, we have never had the slightest bit of difficulty.

J. A. Mathe: I would like to comment on just two factors—toxicity and fire resistance.

Toxicity—Over five years' usage of our water glycol fluids and over two years' usage of our phosphate ester fluid has not produced a single complaint of toxicity or dermatitis. The fluids are used in just about every type of American industry under a great variety of operating conditions and in all Navy catapult systems. Personnel exposure to these fluids has been extensive. Anyone who has ever observed the normal operating and maintenance procedures used on hydraulic equipment realizes that exposure to the fluids cannot be avoided. As a marketer of hydraulic fluids we have made every effort to insure that our fluids are adequately safe for the recommended applications. Just how we do this is worth mentioning.

1. To begin with, the fluids must be formulated to exclude or minimize toxic materials as major components. For example, we use nontoxic glycols in our water glycol fluid. These glycols are actually safer than the permanent type anti-freeze that we use in our cars.

In our phosphate ester fluids the content of ortho-cresol isomer is an important factor in toxicity and is therefore maintained at a low value.

As a further precaution, no chlorinated materials are used in any of our fire resistant fluids.

2. The second step is to obtain actual toxicity test data. For example, extensive tests were run on our phosphate ester fluid before it was marketed which established the limits of the usage of the fluid.

3. The third important step involves government evaluation of the toxicity of our fluids. This must be done in order to obtain government approval for use of the fluids in the armed forces. This has been done for both our water glycol and phosphate ester fluids.

Flammability tests—We use a wide variety of flammability tests in our laboratory including hot manifold, autoignition point, a number of spray flammability tests, wick tests and the Cleveland open cup flash test. Some of these tests do not have clearly defined test procedures so that variations in test results are possible, especially between different laboratories.

However, no matter what test procedure is used we find that the ratings of the various types of fluids always indicate that petroleum oil burns easiest and that the water-in-oil emulsion fluids are the next easiest to burn. It is after this point that argumentation begins. All the tests indicate that water glycol and phosphate ester fluids are better than the water-in-oil emulsion fluids but the test results differ as to the rating of phosphate ester fluid versus water glycol. For example, in any sort of spray test in which the fluid is sprayed into a burning torch it is found that our water glycol fluid cannot be burned.

The phosphate ester fluids usually do burn in spray tests. In fact, in any test where bare flame is used as ignition source the water glycol seems to be superior. In the hot manifold test results vary according to procedure and interpretation. For example, our laboratory reports the following rating on the basis of immediate ignition. In other words, if the fluid does not ignite immediately the temperature is raised until it does.

(a) Oil is poorest.
(b) Water-in-oil emulsion fluid is next.
(c) Phosphate ester fluid was third.
(d) Water glycol is best.

Hot manifold test ratings, based on flame height, produce the same line-up. Ratings based on delayed ignition placed the phosphate ester as better than the water glycol fluid.

I would like to mention one last hazard which has become extremely important in the last year. Usage of oxygen is rapidly increasing as a replacement for air in production of steel. In the missile and rocket field, use of strong oxidizers, such as liquid oxygen, has already become well established. During handling and launching of missiles considerable hydraulic equipment is used. The chances of hydraulic fluid coming in contact with oxygen or oxygen-rich atmospheres is a possibility during such operations.

Laboratory tests have been conducted by a number of authorities in order to evaluate the protection afforded by various types of fire resistant fluids in strong oxidizing atmospheres. The test procedure used is to spray the test fluid into a tube which has a controlled atmosphere in which the oxygen content can be varied. At the end of the tube, a high voltage spark gap is used as a source of ignition. The per cent oxygen needed for combustion can be determined. Test results on various fluids indicated the following:

(a) Oil ignited at 12 per cent oxygen.
(b) Phosphate ester fluids ignited at 19 to 25 per cent oxygen.
(c) Certain water glycol fluids required over 80 per cent oxygen.
(d) One water glycol fluid would not ignite at 100 per cent oxygen.

As a result of this data, our water glycol fluid rather than our phosphate ester fluid will be used in certain types of missile handling equipment. In view of the increasing usage of oxygen in steel mills this factor should be considered.

C. L. Seelbach: Fire-resistant fluids represent a relatively new and sometimes baffling lubrication and hydraulic fluid for the design and maintenance engineer. Most equipment now in use was designed for petroleum base fluids and the maintenance of this equipment has been well established through years of practical experience. Adapting this same equipment to use the new fire-resistant fluids requires patience and ingenuity. Mr. Lewis has demonstrated a high degree of both these qualities in his approach to a solution.

With the research now underway, we can confidently expect improvement in current fluids which will alter and even eliminate present use limitations. Also, as Mr. Lewis points out, equipment modifications and improvements have and are being made which greatly simplify proper application. The review of current practices as outlined by Mr. Lewis is an excellent idea and should be re-examined periodically to benefit from future fluid and equipment improvements.

Member: We have been field testing and laboratory testing practically every type of fire-resistant fluid for the last five to six years. We are using the regular water and oil emulsions, the burnable emulsions, phosphate esters, phosphate base material and the ethylene-glycol type materials. They are making numerous attempts to develop fire or flame resistant tests.

It appears that there is no one single test which will cover all types of fluids. There is now considerable work going on trying to develop tests which will meet all products.

We are using inverted emulsions, on equipment operating as high as 3000 psi. For all the aqueous solutions we limit the operating temperature of the system to 150 F.

However, in selecting a fluid for any particular application in the steel industry, first you have to evaluate the problems encountered in maintenance. For instance, it is not uncommon to have a hose broken, and then you must consider the cost of the various fluids. These may run up to $9.00 per gal for phosphate esters. Now inverted emulsions are much cheaper but still have a drawback. We know that we cannot get as much life out of some types of pumps using an inverted emulsion as with a straight petroleum oil.

Some of the vane type pumps are built with needle bearings and inverted emulsion will not work well with needle bearings. In fact, we have had pumps go out within two and three days with needle type bearings. Another thing is the hardness of the rings and the vanes. We do have some pumps that use a case hardened vane. As soon as you go through the

case hardening, your pump fails readily.

We have chrome plated some of these rings and have had excellent results.

If you do not get a good bond, the chrome plating will flake off and damage your equipment.

We have also tried special hardening rings. We have some rings made out of steel which we feel will be perhaps the answer.

We are using the phosphate esters not only in hydraulics, but in the vacuum pumps, boosters, etc., and we have had excellent results.

The phosphate ester materials seem to give better wear properties than the straight petroleum products.

Ethylene glycol is not much better than the inverted emulsions.

There is one question that I would like to ask. On the one test at 280 F, where you thought that was the temperature of the system, how long did the petroleum oils last in that application?

C. T. Lewis: To the best of my knowledge, we did not experience any adverse effects when the system had been on straight petroleum oil. The 280 F probably would not be the temperature consistently, but whereas the petroleum oil did not show any breakdown or neutralization number increase in the periods of time in which it was subjected to that temperature, the phosphate ester did.

I want to stress in that regard as it was indicated in my paper, this particular set of lines could be considered stagnant at intervals. It actually was two lines to a cylinder which controlled a butterfly valve and at times that valve would lie in one position for hours without any other change. It was during those periods of no fluid flow in which the temperature from external sources had its chance to affect the fluids in the line.

Bear in mind in the use of the petroleum oil there would not be any air present. Consequently the only oxidation which could take place under those conditions would be as a result of whatever small trace amount of oxygen or air dissolved and carried through with the oil, whereas the phosphate ester in the presence of the water and steel as a catalyst did react.

A. E. Cichelli: The only comment I wish to make here is to try to describe what we at Bethlehem are attempting to do in this problem.

There is considerable reluctance to the use of these fire resistant fluids just as there is considerable pressure to do something about the hydraulic oil fire hazard.

A committee was formed in the general offices composed of representatives from operation, safety, fire protection and the medical divisions. We established, after contacting numerous suppliers, certain criteria intended to evaluate the many systems we had as either high hazard, medium hazard, low hazard and no hazard.

A questionnaire was prepared and distributed to all of our facilities, the questionnaire containing 22 exacting questions pertaining to design and hazard data for each system.

The questions included such as these: How many gallons in the tank? How long are the pipe lines? How far away are they or any part of the system from the ignition source? How many times did you have a fire? What are you using now? What is the possible ignition source? What types of pumps are you using, etc.? The survey left little to the imagination.

By use of the hazard criteria for high, medium and low hazard, plants assigned a code letter to each system, designating the degree of hazard. Upon receipt of the plant replies we rearranged them and sent the same information to pump manufacturers and fluid suppliers, asking them, in effect, "what would you do if this was your system?"

The pump manufacturers almost universally have reservations. Fluid "A" should not be used in their pump else you will enjoy 50 per cent wear. Not all were so blunt, but at the same time, replies were generally cautious.

The fluid suppliers were just as cautious. They told us, "From a fire resistance standpoint, this is what you can expect. As far as the pumps are concerned, you should not get any more wear than you do now. Our experience is so-and-so."

Again, we collected this new information, reassembled it and returned the project to the plants. A systematic program for reducing and eliminating fire hazards in hydraulic systems has gone into effect, each plant to restudy its systems, using as a guide the procedure developed by the committee.

Essentially, they will try to determine the economics of correcting a system by use of water, if possible, or by diverting a pipe line, or by relocating a tank, etc., versus changing to another fluid.

It is now the plants' responsibility to make the necessary correction, but at this point we have at least taken one valuable step.

Now we know where our hazards are, their nature and how we can cope with them. Whether or not we convert to a fire resistant fluid or not, we do not now know as each case will have to be handled as a separate unit.

We owe much to the fluid suppliers for their efforts in attempting to provide the lubricating qualities of a petroleum oil into a fluid that will not burn.

When the pump manufacturer designs his pump, so as to better cope with these fluids, then there will be even more progress.

J. T. Rea: I did not hear anyone say anything about the danger of a man suddenly getting saturated with flammable type fluid near a flame. We once had that happen, and the man was killed.

I think every one of our discussions should have that thing right at the front of it. You get a man who is saturated with pressure atomized flammable fluid, near flame or high temperature and we all know that his clothing may ignite with probably fatal burns resulting. This is our most important reason for fire-resistant fluids.

C. T. Lewis: In the paper I tried to stress the fact that flame may result from atomization and ignition of almost any fluid, at least to some degree. Wherever any flame with any oxidation takes place, there is an increase in temperature and as I pointed out in the paper, a person incapacitated as a result of this mishap is subject to burning in proportion to the heat liberated.

Last winter in one of the eastern steel companies, a rubber hydraulic hose on a hot mill stand let go, squirted the petroleum oil past an adjacent coke jack and fatally burned two men standing beyond the coke jack. ▲

Backup Rolls And Their Contribution To Gage Variation

by EARL G. LINDSEY,
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. . . . defective rolls can cause marked gage variation . . . . product uniformity has been markedly improved by applying scientific control to roll shape and quality . . . .

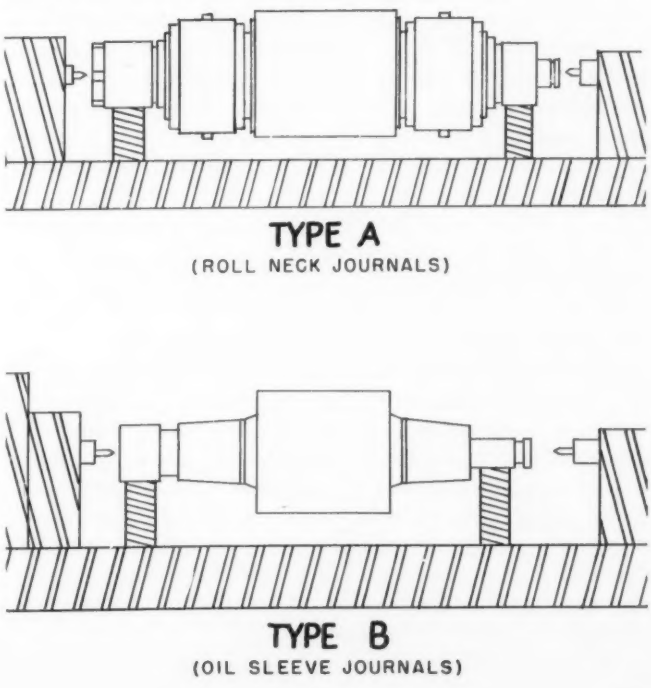
THE multiple stand cold reduction mills introduced in recent years produce a fine product and are a great improvement over previous methods. Thickness and surface are consistently good and assist in making many fabricating operations more economical. As fabricating speeds increase, the need for an even better product will result. The control of thickness or gage to a more consistent measurement with minimum variation within commercial tolerances has been demanded by many customers.

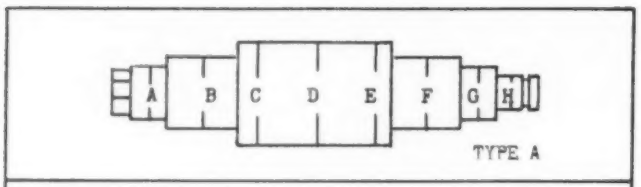
Variation of gage along the length of finished strips has become an important consideration. One of the most important aspects in minimizing this variation is accurate grinding of roll bodies. An evaluation of grinding accuracy became available with the development of a practical and accurate gage recorder which has generally been a component of noncontacting type strip thickness gages. This paper reviews roll shop practices which have been found to improve gage on a cold reduction 5-stand mill producing tinplate in gages of 0.0078 to 0.0123 in. decimal thickness.

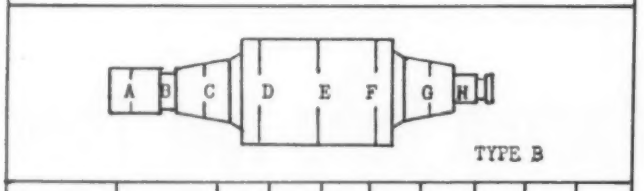
Grinding and assembling services performed by roll shops, if not properly and accurately performed, can cause eccentricity of rolls, which in turn could cause gage variation. Backup rolls, because of their design, are apt to be eccentric due to grinding. Modern design of backup rolls demand they be ground on the outboard ends of both the thrust and float end necks. During this grinding cycle it was common practice to dial indicate the roll body and outboard ends of the necks to determine concentricity. In most cases the body was within 0.001 in. true because the outboard ends of the necks, which are being used as journals, were true. This was a good check but did not give the true picture because the journals of the roll used in grinding were not the journals used in mill operation. This problem does not occur with work rolls as the journals are the same for mill operation as used in grinding.

Figure 1 illustrates these two different designs. Type "A" is designed so the bearings will remain intact on the necks during the grinding cycle. This is a sleeve bear-

Figure 1 — Two different types of backup roll bearings require different procedures for proper grinding.







ROLL NO.	MILL	A	B	C	D	E	F	G	H

DATE	TURN	MACHINE
GRINDER OPERATOR		FOREMAN

Figure 2 — This report form is used for dial measurements on backup rolls.

ing of the babbit type with a roller thrust. The roll neck is used as a journal. The journals under these bearings are a highly polished surface which would eliminate them as journals for grinding even though the bearings could be removed each time the roll is ground. Type "B" is a sleeve bearing with roller thrust designed for the bearings to be removed during the grinding cycle, but has a tapered neck to receive a journal sleeve which will not allow them to be used as grinding journals. Regardless of how true a backup roll was ground on these outboard journals, the concentricity could change after assembling because different journals are used in the mill than those on which the roll has been ground. Thus further work in dial indicating of the roll was needed while the grinding operation was in progress. In addition to dial indicating the body and outboard journals it is necessary to dial indicate the entire roll to accurately pinpoint the source of eccentricity.

Figure 2 illustrates the location of those points which are dial indicated while the roll is in the grinder and serves as a report by the grinding operator. Type "A" design is dial indicated at points A, C, D, E, G, and H before and after grinding each time a roll is processed. Points B and F are tested with a dial indicator only in those cases where there is evidence of eccentricity after the roll is removed from the mill. This design requires the bearings to remain intact on the roll during the grinding process.

Type "B" is tested with a dial indicator at all points shown each time it is ground paying particular attention to C and G because these surfaces are the journals that will be used in the mill. If these two points are eccentric by 0.003 to 0.004 in. they are ground to make them concentric. Extreme care must be exercised during this operation to insure that the tapered necks are not ground below the specified tolerance which is plus or minus 0.0035 in. To exceed this tolerance means inviting gage variation because of improper fit of the bearing on the tapered neck. Details of this problem are discussed later.

If all the above points on each type of roll indicate true concentricity, grinding cycle has been performed accurately and the next step is to assemble the bearings on the roll for use in the mill.

The practice for a number of years has been to carefully slide the bearing on the roll neck to prevent scraping or dislodging metal from raised keys. If there is no evidence of metal particles and the bearing goes into position easily, the bearing is tightened and sent to the mill to be put in use.

It was at this point that a second change was made in the practice. It is true that if a large piece of metal broke off the key, the bearing would not fit properly on the roll neck making it necessary to dismantle the roll to determine the reason. However, it was not the large pieces that were alarming because they were easily detected. What if the piece dislodged was only 0.005 in. thick? A bearing as large as this would go completely up and still have such a piece between the sleeve and the neck, and if allowed to remain would give eccentricity to the roll even though the roll was ground perfectly and dial indicated true. Realizing this, it became evident that a way to check the roll for concentricity after it was assembled and ready for use in the mill must be developed. A method of checking was devised which is shown in Figure 3.

When the assembly is complete the roll is removed from the rack and placed on a reasonably level surface. A cable sling is given about three wraps around the float neck and then attached to the crane hook. A dial indicator on a stand is placed against the body of the roll and the crane rotates the roll slightly to establish an oil film and then turns the roll so that the dial indicator may be read. Extreme care must be taken not to raise the hook too fast or the roll will move up a small amount and a false reading will be obtained. However, this action is readily detected on the dial indicator. As the roll turns, a reading for concentricity may be taken from the dial indicator. If the roll is true and it has no internal defects that will cause it to open under pressure, it means it will run true in the mill because it has been dial indicated on the same bearing surfaces that will be used in the mill. A more accurate driving means will be provided after further evaluation of this concentricity checking method. In the case of the top roll, it is unnecessary to place the chocks bottom side up in order to indicate on the actual load area of the bearing. Further study of this is in progress at present.

These practice changes are very necessary to eliminate eccentricity (which in turn reduces one cause of gage variation) but they are of no value unless the roll itself is sound. Perfect grinding and assembling may be achieved, and yet the roll might still be eccentric in the mill because an internal defect may cause the necks to

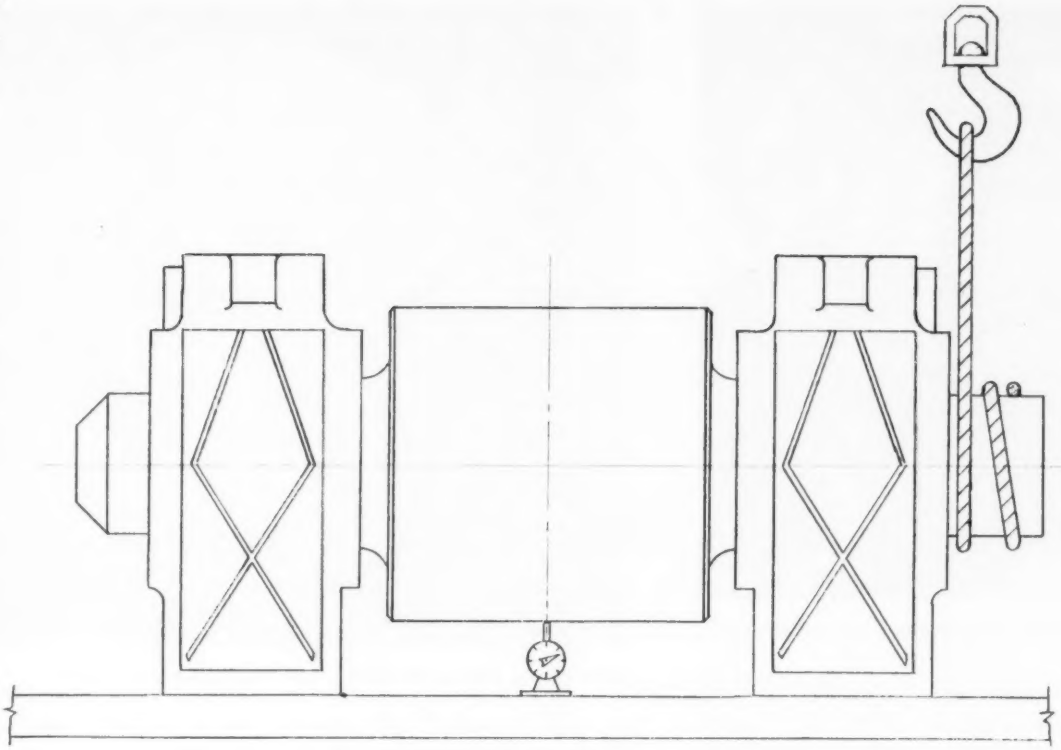


Figure 3 — Diagram shows one method of checking concentricity of backup rolls.

bend under pressure. An ultrasonic gage was purchased for use in detecting these internal defects before they cause trouble.

This gage produces pulses of ultrasonic vibrations which are introduced into the material under test at right angles to the testing surface by means of a searching unit which contains an X-cut quartz crystal. When the vibrations are interrupted by an internal crack, pocket, inclusion or other discontinuity, or by the far side of the material, they are reflected back to the searching unit. The quartz crystal converts the vibrations into electrical impulses. These appear on the screen of a cathode-ray tube as vertical indications along a line of square wave markers. The markers represent units of distance. The "initial pulse" indicates the testing surface. The "back reflection" indicates the reflecting surface. Indications between these two references show discontinuities in the material, and their positions along the markers accurately locate the discontinuities in relation to the surfaces. Examples of these sound waves, as seen on the screen of the reflectoscope, are illustrated in three sketches of Figure 4. The top sketch shows the screen with power on and ready for testing. The middle sketch shows the screen when the section of material being tested is sound and no defects indicated. The bottom sketch shows the screen when a section of material being tested indicates a defect. This indication appears between the initial impulse and the back reflection. Once a defect is indicated the crystal is moved back and forth to obtain defect location and size. To illustrate types of defects which have been located, with the aid of the gage it is necessary to show actual photographs of some of the rolls that have been tested and photographed after failure.

Figure 5 shows a forged steel arbor after breaking due to fatigue. Figure 6 shows a cast steel arbor after breaking due to fatigue.

The next practice change was to incorporate the ultra-

Figure 4 — Ultrasonic gages are used to locate interior defects.

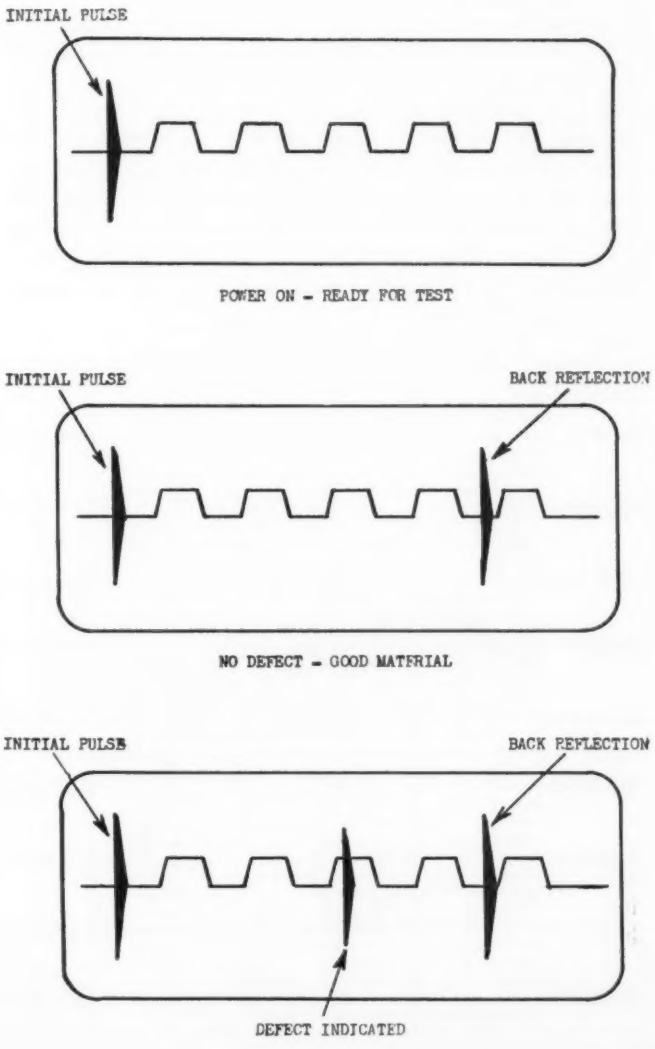


Figure 5 — This forged steel arbor broke due to fatigue.

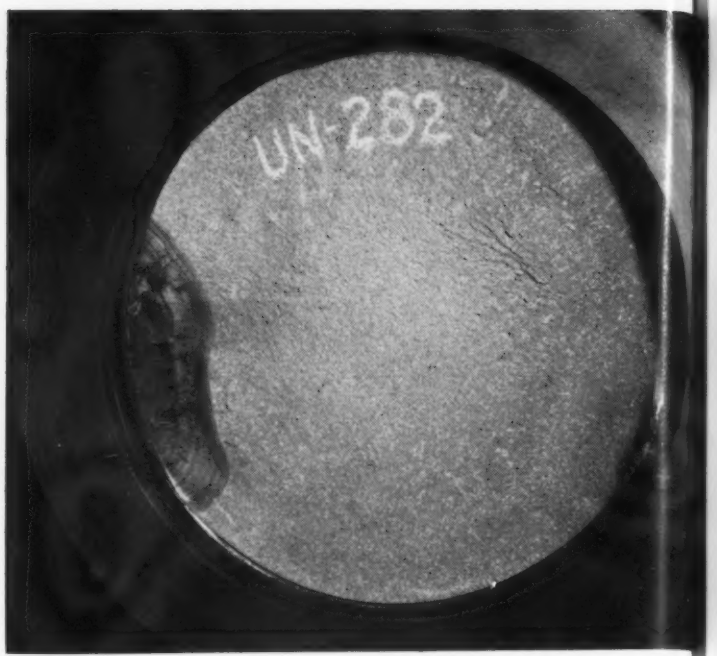


Figure 6 — This cast steel arbor broke due to fatigue.

sonic gage testing on a regular basis along with the dial indication. Three practice changes have been mentioned, but basically they are different aspects of one change. Each of them was initiated to eliminate gage variation caused by roll eccentricity.

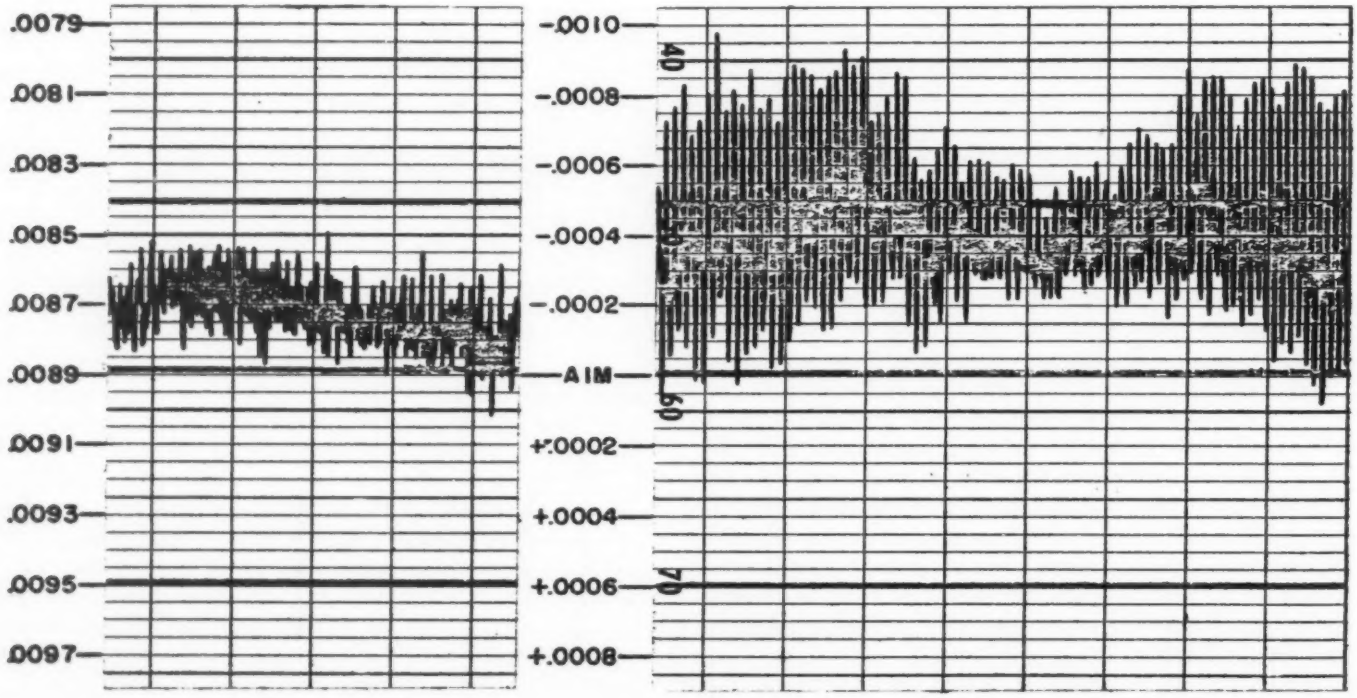
Figures 7, 8, 9, 10, 11 and 12 illustrate gage variation recorded by a noncontact thickness gage. This variation was caused by different types of eccentric rolls.

Figure 7 shows variation as recorded on an electrolytic tinning line and was caused by an eccentric backup roll in the 5-stand tandem mill. This backup roll was eccentric due to a defective neck which indicated that it was concentric in the chocks, but it was permanently deformed, thus creating an out of round condition. The right portion of the chart shows the effect of this roll on gage variation and the left portion shows the same product as produced after the roll was changed.

The product was checked at several processing lines preceding final coating to determine if the assumption was correct. Figure 8 was taken at high speed from the same product. The right portion is before and the left portion after the roll was changed.

Figure 9 was recorded from the side trimmers after the same product had been temper rolled. The right portion of the chart was recorded before and left portion after changing backup rolls. The gage proved the roll neck was defective due to fatigue, and it was scrapped. Without the gage it would have been baffling to determine the cause of this variation. This example

Figure 7 — This backup roll was eccentric due to defective neck. Gage readings were taken in an electrolytic tinning line running at 800 fpm.



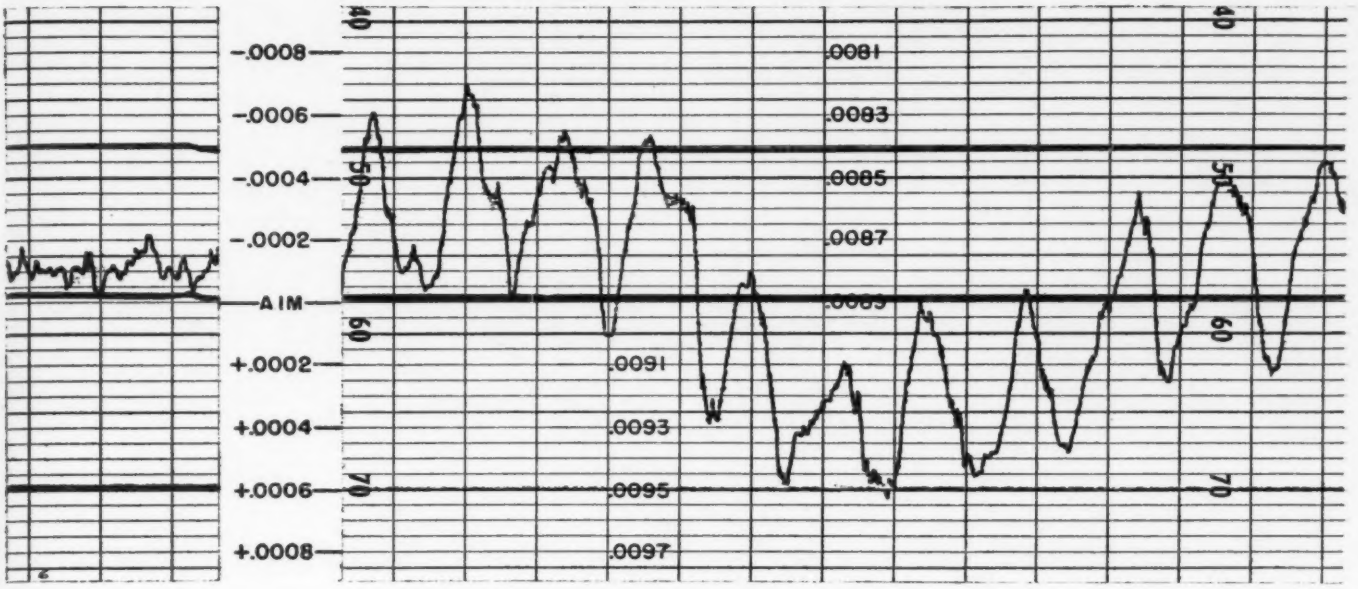


Figure 8 — Wide variation in gage due to defective rolls are also shown by the comparisons of the gage charts.

clearly indicates that the grinding and assembling dial indication test is not enough by itself. The ultrasonic gage must be used to determine if the roll itself is structurally sound.

Figure 10 was taken at the electrolytic tinning line and also shows gage variation resulting from an eccentric backup roll, but the eccentricity was due to a different cause. The eccentric action resulted from excessive grinding of the tapered necks of the backup roll. This was caused by attempting to eliminate the eccentricity of the necks, which was accomplished. However, tapered necks and sleeves must fit properly or the chock moves farther up the taper and eccentricity developes due to improper fit and spacing, which occurred in this case. This roll, an example of type "B" illustrated earlier, was removed from service.

Figure 11 shows variation as recorded on the cleaning lines caused by another eccentric backup roll. This eccentricity was caused by the sleeve slipping six in. along the periphery of the arbor. The right portion of the chart shows before the roll was changed and the left portion after.

Figure 12 shows the same variation on the same product as Figure 11 but recorded with a contact type thickness gage on the 5-stand tandem mill. The right portion is before changing rolls and the left portion is after.

This variation was recorded by two methods in order to obtain more complete data for analysis. In order to determine easily this source of eccentricity, the sleeve and arbor are center punched at the time the arbor is sleeved. These marks are inspected each time the roll

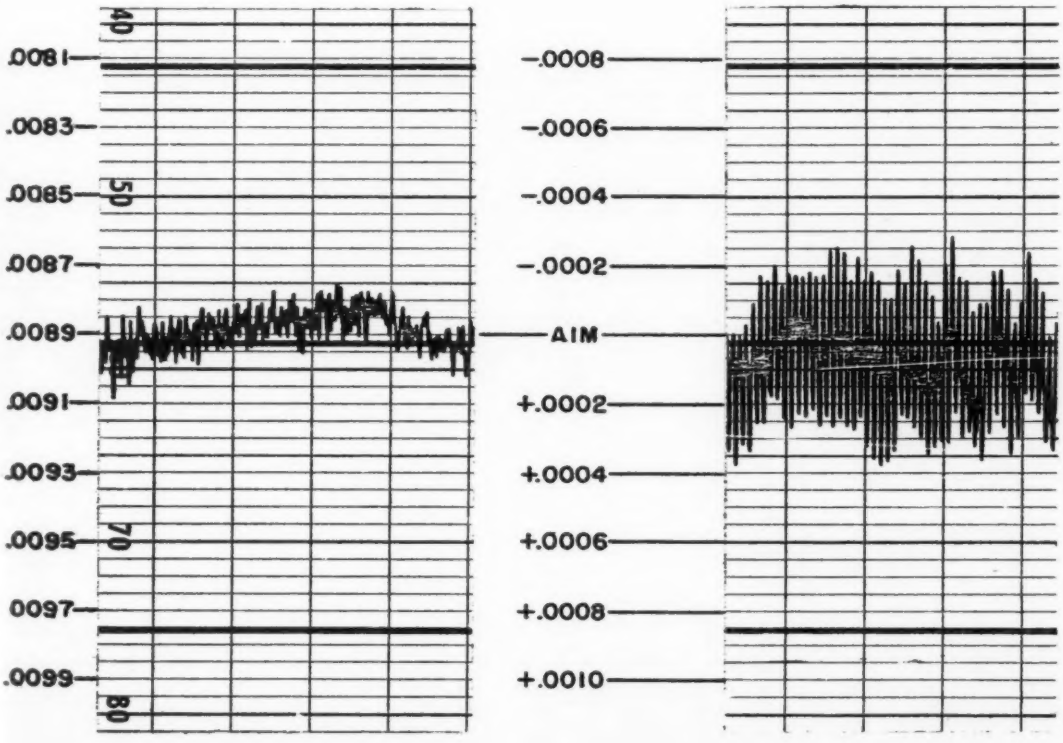


Figure 9 — Gage readings at side trimmer also show variation in gage due to defective roll neck.

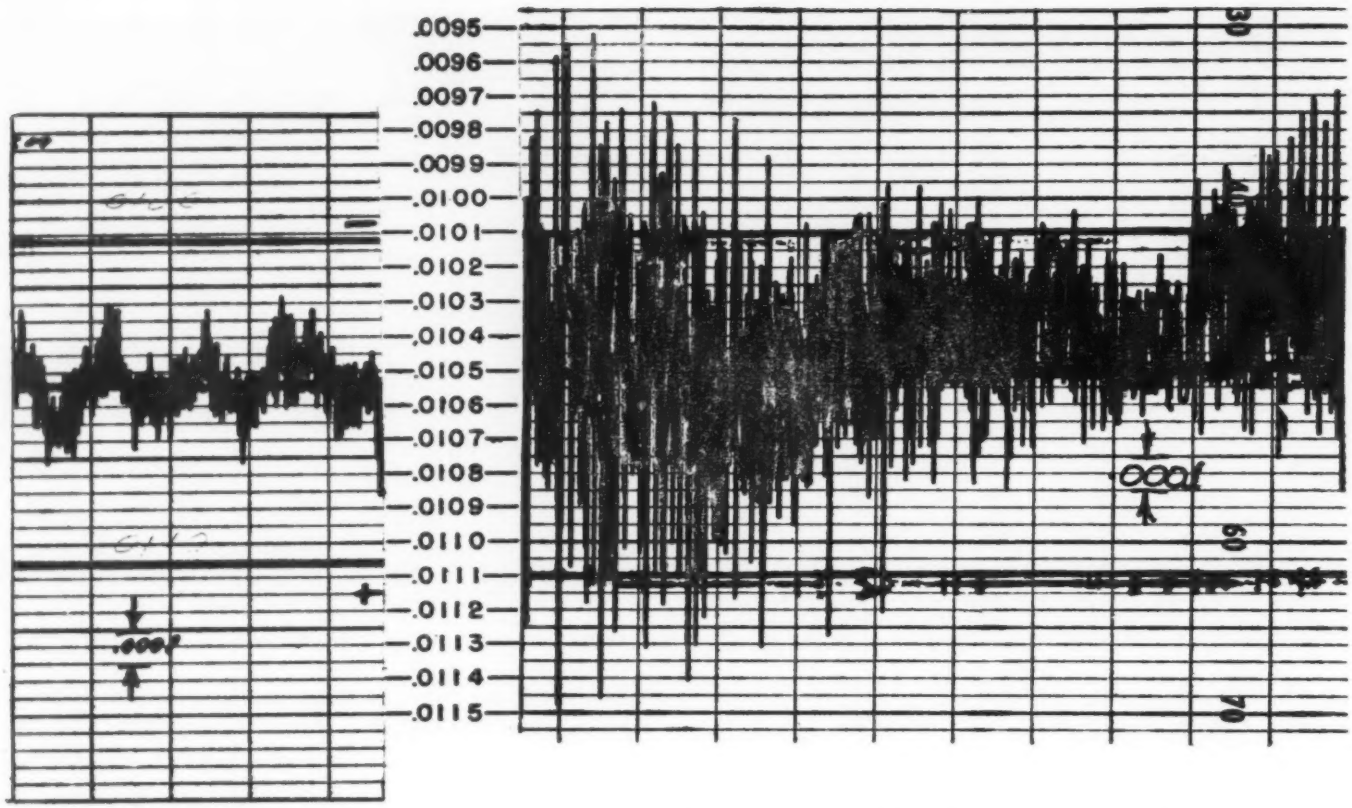


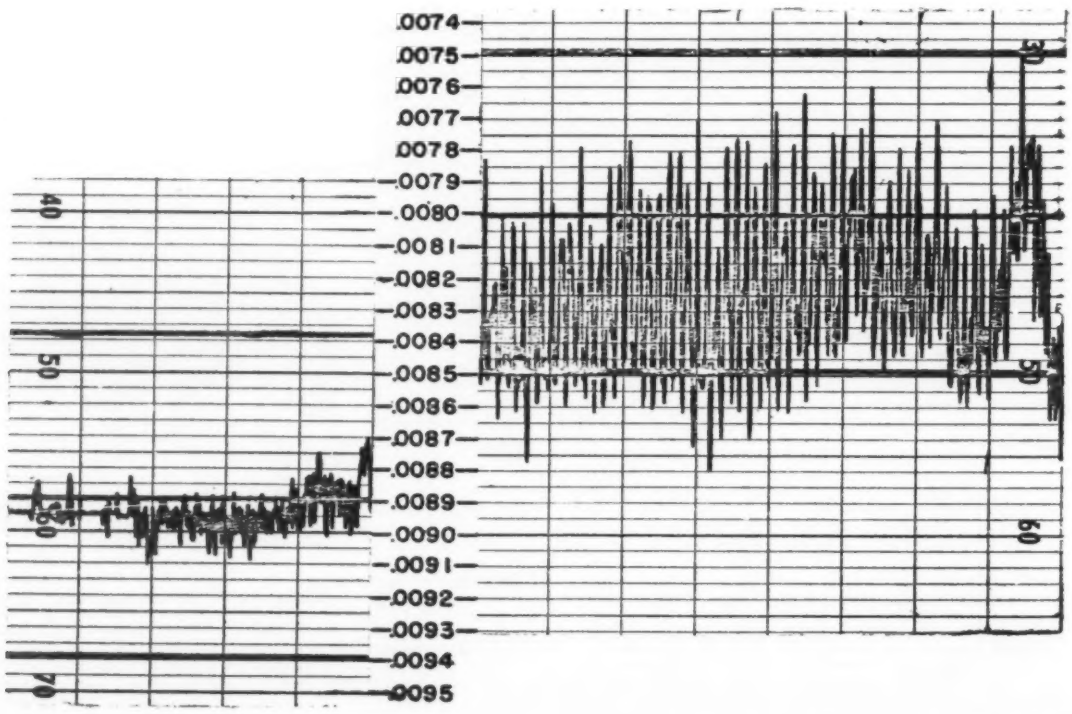
Figure 10 — Eccentricity here was due to excessive grinding of the taper necks. The effect on gage is marked.

is removed from the mill to observe if any slipping has occurred.

After observing the charts of gage variation, it is apparent that everything possible must be known about the condition of the roll before and after use in the mill. These conditions must be recorded each time so that a complete history of the roll is maintained for future disposition. Several forms have been designed to assist in the compilation of a history.

Figure 13 illustrates the form that is used to plot the location of spalls, mill creases and body conditions after the roll has been used in the mill. The periphery of the roll has been placed horizontally on paper for ease and accuracy in plotting. By facing the thrust end of the roll in line with the sleeve retainer key, it enables plotting defects in inches to the right or left and how far from the end of the body. This example shows a mill crease caused by the screws being run down too far while the rolls were not rotating. Electrical trouble was encountered on this occurrence, and the foreman has made this note on his report. On the left side of the sketch a spall is plotted so we can watch to see how

Figure 11 — Eccentricity due to sleeve slipping gave marked gage variations.



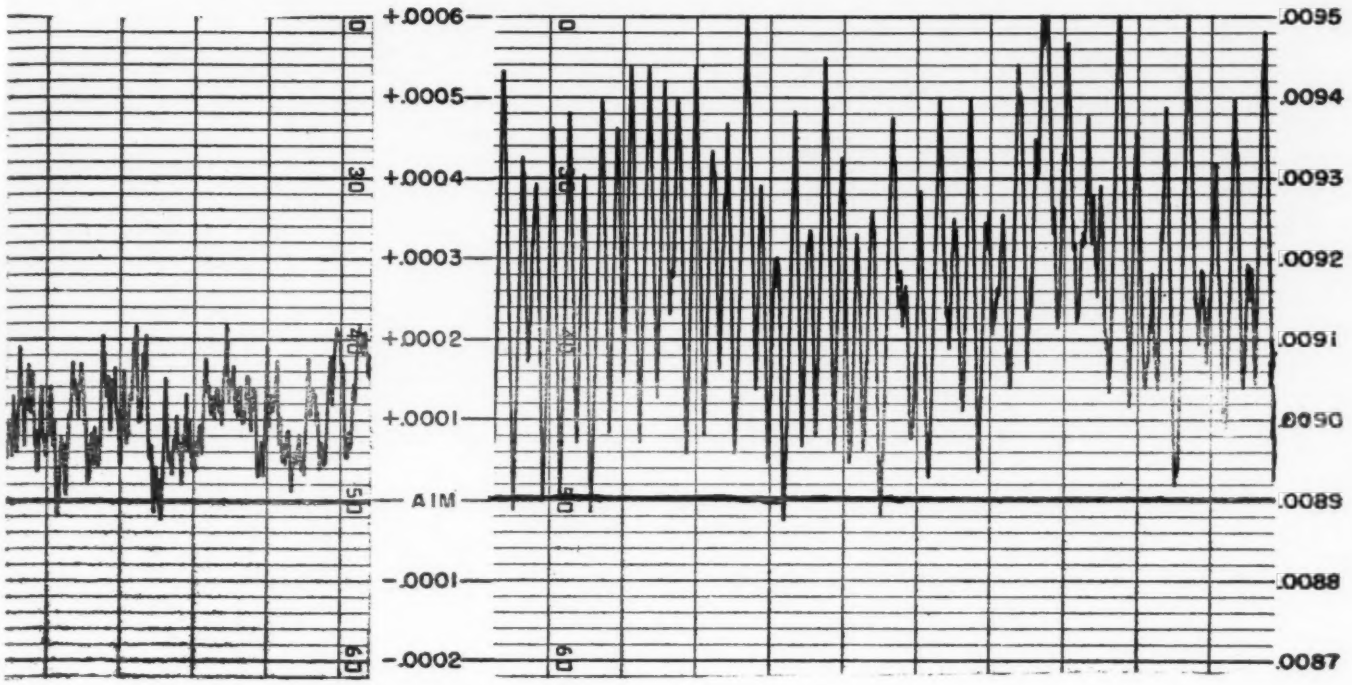


Figure 12 — Gage located on 5-stand cold reduction mill shows variations recorded by contact type thickness gage.

Figure 13 — This card is used to record damage location on rolls.

COLUMBIA ROLL NO. _____

MAKERS' NO. _____

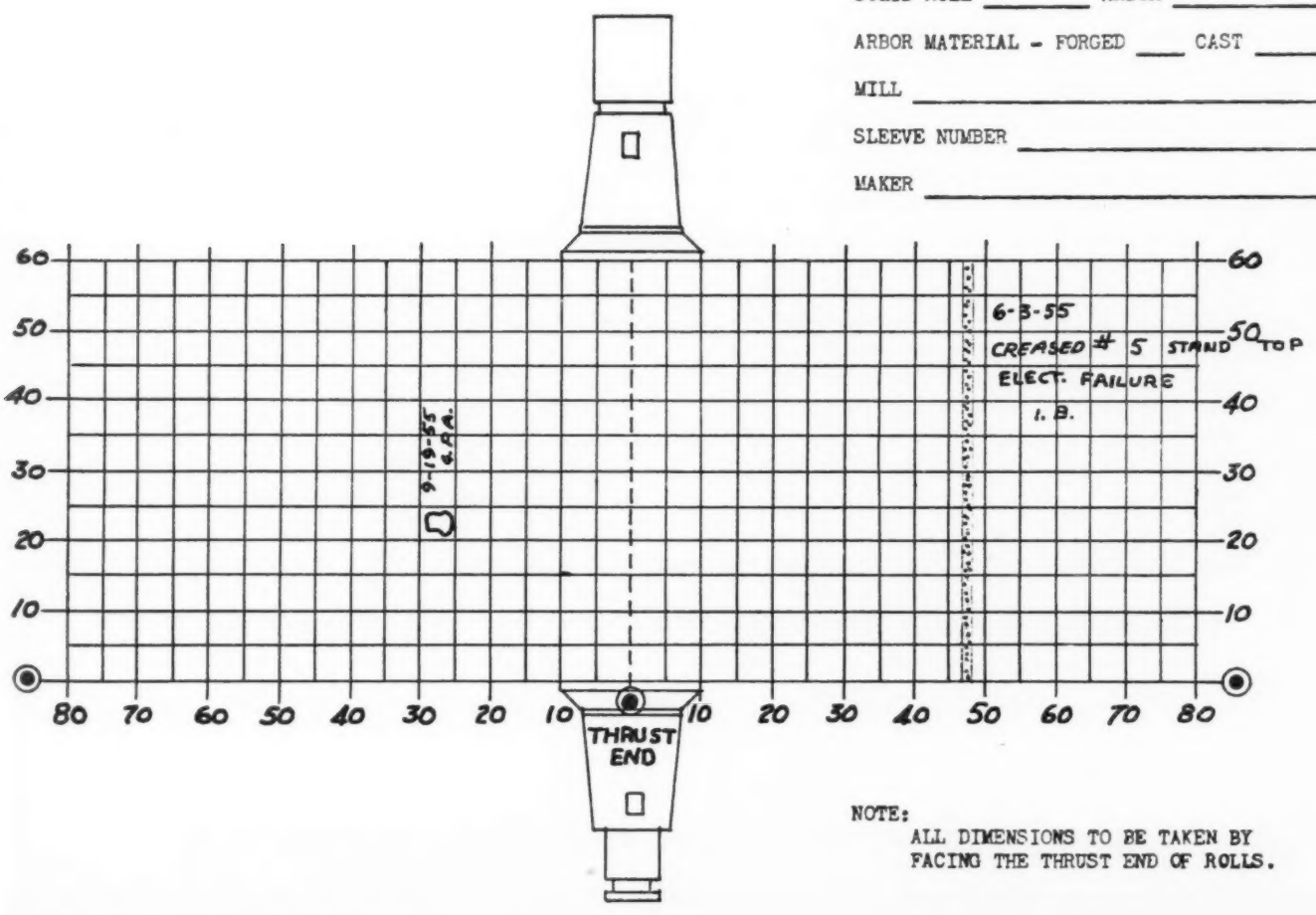
SOLID ROLL _____ ARBOR _____

ARBOR MATERIAL - FORGED ___ CAST _____

MILL _____

SLEEVE NUMBER _____

MAKER _____



NOTE:
ALL DIMENSIONS TO BE TAKEN BY FACING THE THRUST END OF ROLLS.

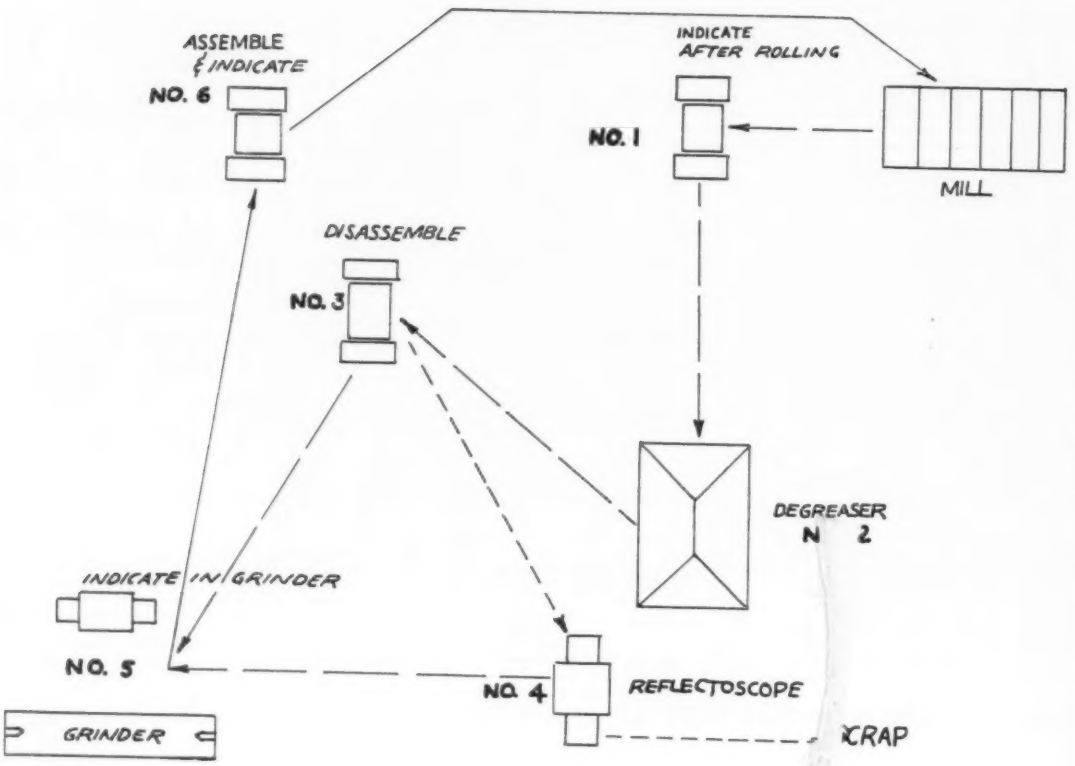


Figure 14 — Schematic shows sequence of tests in production flow.

much it enlarges and what disposition will be necessary. Excessive mill creases cause the roll to deflect and bend which may cause gage variation if not corrected. This form helps in the analysis of the causes of gage variation resulting from eccentric backup rolls.

Several practice changes have been discussed in our roll shop procedures and how we applied them to reduce gage variation caused by eccentric backup rolls. Figure 14 will demonstrate where and when in the flow of production we apply these tests.

1. Dial indicate each backup roll in the chocks after it has been removed from the mill. The roll was concentric before it went into the mill and this check will give an indication, if it is eccentric, of an internal defect, or sleeve slipping, or neck having been bent during operation.

2. Send the roll to the degreaser to remove excess grease for ease in visual inspection. After degreasing, plot any body defects on chart for future reference.

3. Dismantle the roll and send to the grinder for processing if eccentricity was not shown in step no. 1. If eccentricity did occur in the mill, send the roll to no. 3A for ultrasonic gaging, sleeve slippage and neck measurement.

4. Grind and indicate all points while roll is in grinding process to insure concentricity.

5. Assemble the roll and dial indicate in the chocks to be positive no pieces of metal have sheared from the key and lodged between the sleeve and neck. This step will indicate how the roll will operate in the mill.

6. Send the roll for installation in the mill. When the roll is put into operation, observe the mill gages to see if any indication of eccentricity is present.

7. Observe the first two coils rolled and send them to the electrolytic cleaning lines to process while the noncontact thickness gage is observed to indicate tolerance and variation within tolerance. This line is operated at the same speed that the electrolytic tinning line is operated to provide charts which are comparable. Experience has indicated that the gage installed on the cleaning lines verifies a variation in gage immediately after rolling resulting in immediate corrective action.

It is not suggested by the foregoing that roll concentricity is the sole factor in reducing gage variation. However, its effects as a factor can be minimized by changing only a few established practices. Further investigation of all rolling processes will be necessary to reduce gage variation to the optimum value. ▲

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PROGRAM

AISE SPRING CONFERENCE

Auspices of Rolling Mill Committee

SHERATON HOTEL
PHILADELPHIA, PA.

April 25, 26, 27, 1960

MONDAY, APRIL 25

8:30 am—REGISTRATION—
Parlors C–D

9:00 am—ELECTRICAL SESSION—
Independence and Constitution Rooms

Chairmen: R. G. Nolan, Electrical Engineer, Granite City Steel Co., Granite City, Ill.

H. W. Dorset, Assistant Electrical Superintendent, Bethlehem Steel Co., Sparrows Point, Md.

"Hot Strip Mill Electrical Systems—Design Trends," by W. M. Krummel, Steel Mill Application Engineer, Metal Rolling and Processing Engineering, Industrial Engineering Section, General Electric Co., Schenectady, N. Y.

"Automatic Gage Control on Reversing Cold Strip Mills," by Alonzo F. Kenyon, Advisory Engineer, Industrial Engineering Dept., Westinghouse Electric Corp., East Pittsburgh, Pa.

"A Program for Automation of High Speed Temper Mills," by D. E. Rea, Application Engineer, Industrial Systems Dept., and R. C. Lopez, Control Engineer, Control Dept., Allis-Chalmers Manufacturing Co., Milwaukee, Wis.

9:00 am—ROLLING MILL SESSION—
Pennsylvania Room

Chairmen: F. G. Kredel, Chairman of Bar Mill Committee, Republic Steel Corp., Cleveland, Ohio

H. S. Millington, Mill Engineer, Bethlehem Steel Co., Bethlehem, Pa.

"Retaining Flexibility in the Design of Mechanized Merchant Bar Mills," by Edward C. Peterson, Vice President, Rolling Mill Equipment Div., and William H. Boblitz, Roll & Mill Machinery Sales Engineer, Birdsboro Corp., Birdsboro, Pa.

"The Operation of a Three-Strand High Speed Rod and Merchant Mill," by A. H. Griffiths, Superintendent of Rolling Mills, Sheffield Div., Armco Steel Corp., Kansas City, Mo.

"Investigation of Spalling of Work and Back-Up Rolls in Hot and Cold Strip Mills," by James V. Latorre, Research Engineer, and M. K. Chakko, Metallurgical Research Laboratory, Syracuse University Research Institute, Syracuse, N. Y.

2:00 pm—ROLLING MILL SESSION—
Pennsylvania Room

Chairmen: Howard S. Orr, Project Development Engineer, United States Steel Corp., Pittsburgh, Pa.

R. C. Schaefer, Assistant Superintendent, Hot Strip, Soaking Pit, and Blooming Mill Dept., Wheeling Steel Corp., Steubenville, Ohio

"Roll Wear in Finishing Trains of Hot Strip Mills," by Dr. George Sachs, Associate Director, James V. Latorre, Research Engineer, and M. K. Chakko, Metallurgical Research Laboratory, Syracuse University Research Institute, Syracuse, N. Y.

"Instrumentation for Hot Strip Mill Test Program," by N. S. Wells, Section Head-Application, Special Controls and Drives, Electrical Dept., The Steel Co. of Canada, Ltd., Hamilton, Ontario, Canada

"Analysis of Operational Factors Resulting From Hot Strip Mill Tests," by John S. Ride, Metallurgist, Development and Special Duties Div., Metallurgical Dept., The Steel Co. of Canada, Ltd., Hamilton, Ontario, Canada

2:00 pm—COMBUSTION SESSION—
Independence and Constitution Rooms

Chairmen: William M. Bloom, Senior Fuel Engineer, Allegheny Ludlum Steel Corp., Brackenridge, Pa.

E. W. Fitch, Chief Combustion Engineer, Republic Steel Corp., Youngstown, Ohio

"Profit Improvement Through Waste Fuel Utilization," by R. E. Leip, Utilities Coordinator, Fairless Works, United States Steel Corp., Fairless Hills, Pa.

"Investigations into Transient Temperature Distributions Within Slabs Heated in Continuous Furnaces," by A. H. El-Waziri, Senior Technologist, Applied Research Laboratory, United States Steel Corp., Monroeville, Pa.

"European Experience with the Electrically Heated Soaking Pit," by Harald C. Bjerke, Special Engineer, Rust Furnace Co., Pittsburgh, Pa.

TUESDAY, APRIL 26

9:00 am—MECHANICAL SESSION— Independence and Constitution Rooms

Chairmen: G. M. Kyle, Assistant Mechanical Superintendent, Indiana Harbor Works, Inland Steel Co., East Chicago, Ind.

Charles H. Good, Jr., Chief Engineer, Central Operations, Fairless Works, United States Steel Corp., Fairless Hills, Pa.

"Ductile Iron in Steel Mills—Its Properties, Applications and Usefulness in Operations and Maintenance," by Charles R. Isleib, Metallurgist, Ductile Iron Div., The International Nickel Co., Inc., New York, N. Y.

"Some Concepts of Mill Bearing Lubrication Employing Oil, Plastic Grease and Oil Mist," by O. G. McCandless, Lubrication Advisor, Butler Plants, Armco Steel Corp., Butler, Pa.

"Trends in Rolling Mill Drive Design," by Roger Jones, Sales Manager—Metal Producing Industries, Industrial Products Div., Western Gear Corp., Belmont, Calif., and Royal Hawley, General Supervisor, Design Engineering, Seattle Works, Western Gear Corp., Seattle, Wash.

9:00 am—ROLLING MILL SESSION— Pennsylvania Room

Chairmen: J. L. Dawson, Superintendent, Blooming, Hot Strip & Rolling Mills, Jones & Laughlin Steel Corp., Aliquippa, Pa.

W. E. Dittrich, Superintendent, No. 2 Mills Dept., Indiana Harbor Works, Inland Steel Co., East Chicago, Ind.

"An Analysis of the Stresses and Deformations in Work Rolls," by Carl F. Zorowski, Assistant Professor of Mechanical Engineering, and Alvin S. Weinstein, Assistant Professor of Mechanical Engineering, Carnegie Institute of Technology, Pittsburgh, Pa.

"Soaking Pit Expansion and Installation of Slabbing Mill at Kaiser Steel's Fontana Plant," by M. L. Gruver, Superintendent, Blooming, Slabbing and Structural Mills, Fontana Works, Kaiser Steel Corp., Fontana, Calif.

"46-In. Blooming and Plate Mill," by J. L. Laidlaw, Manager of Engineering and Construction, and J. H. Walshaw, Superintendent, 46-In. Blooming and Plate Mill, Algoma Steel Corp., Ltd., Sault Ste. Marie, Ontario, Canada

2:00 pm—OFF-THE-RECORD ROLLING MILL PANEL DISCUSSION—

FIRE-CRACKING IN ROLLS SESSION—Combined Meeting with Roll Manufacturers Institute— Pennsylvania Room

Moderator: John Dugan, Vice-President—Operations, The Ohio Steel Foundry Co., Lima, Ohio

RMI Panel: W. D. Hocker, Superintendent, Foundry Operations Mesta Machine Co., West Homestead, Pa.; J. W. Luoma, Technical Assistant, Roll Sales Dept., Blaw-Knox Co., East Chicago, Ind.; E. P. Sandbach, Chief Metallurgist, Mackintosh-Hemphill Div., E. W. Bliss Co., Pittsburgh, Pa.

AISE Panel: E. M. Benedict, Superintendent—Roll Shop, South Works, United States Steel Corp., Chicago, Ill.; James N. Imel, Superintendent, Sheet & Tin Strip Depts., Pittsburgh Works, Jones & Laughlin Steel Corp., Pittsburgh, Pa.; Louis Moses, Bethlehem, Pa.; H. E. Muller, Superintendent Roll Dept., Indiana Harbor Works, Inland Steel Co., East Chicago, Ind.

7:00 pm—INFORMAL STAG DINNER— Grand Ballroom

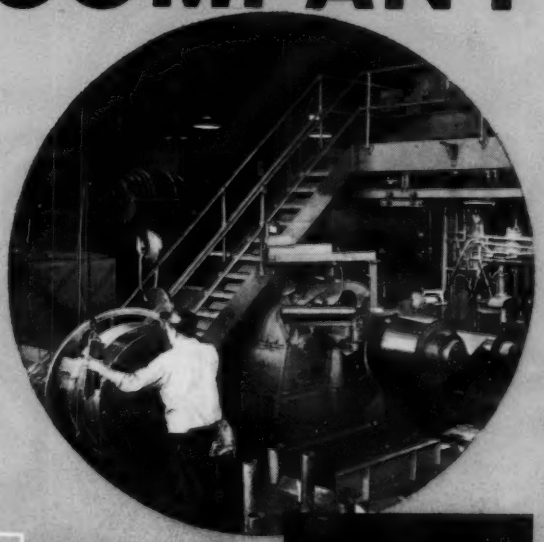
Speaker: Harleson R. Wood, President, Alan Wood Steel Co., Conshohocken, Pa.

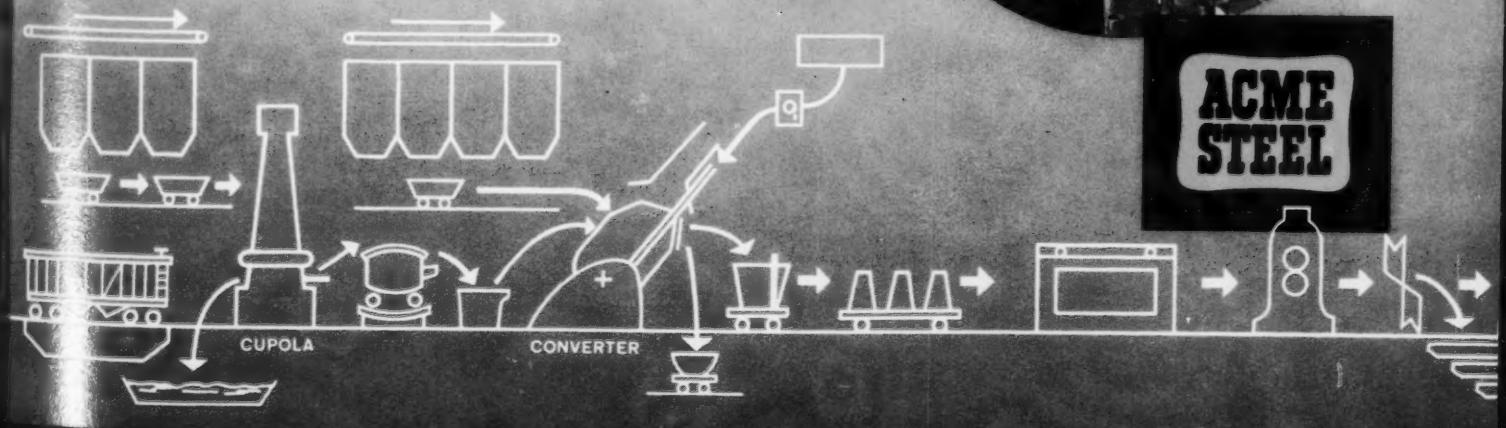
WEDNESDAY, APRIL 27

8:25 am—INSPECTION TRIP—

Bethlehem Steel Co., Bethlehem, Pa. Special train leaves from Reading Railroad Terminal at 12th & Market St., in downtown Philadelphia. All attending trip will assemble at Reading Terminal. Allow at least 20 minutes to walk to station from Sheraton Hotel. Train will leave Bethlehem at 2:00 pm and arrive in Philadelphia at 3:20 pm. Box lunches will be served on return train trip, courtesy of Bethlehem Steel Co.

ACME STEEL COMPANY





ACME STEEL

ACME STEEL COMPANY

ACME Steel might be called the company that grew from a staple. In 1880, a furniture dealer, M. E. McMaster, aggravated by packing damage to his shipments, began to experiment with hoop steel. He devised a staple with barbs on each end which held bed rails safely during shipment and effectively prevented damage. He patented his staple, designed a machine for its manufacture and found a ready market for the new product in packaging and crating.

By 1900, the company had become the Acme Flexible Clasp Co. and eventually entered the steel strapping field. Later, it also expanded into the manufacture of strapping tools.

By 1917, it became clear that facilities for rolling steel strip were essential. In 1919, a continuous hot mill

went into operation, rolling purchased billets into strip. This was built on a new site at Riverdale, Ill., on the Little Calumet River, about 16 miles south of downtown Chicago.

Through the years, the company and the Riverdale plant has expanded, adding more hot mills, cold mills and finishing equipment to meet the growing demand for hot and cold rolled strip.

Acme Steel Co.'s main plant is still at Riverdale, where the company has continued to convert purchased billets and slabs into hot rolled and cold rolled carbon steel strip. It also manufactures steel strapping, strapping tools, flat stitching and wire stitching machines, steel hoops, slotted angles and other specialty products.

Finding its dependence on outside steel sources frequently placed it in a precarious position from the standpoint of availability and price, Acme made its first step toward integration by acquiring Newport Steel Corp. at Newport, Ky., in 1956. This wholly owned, semi-integrated subsidiary is now operated as the Acme-Newport Steel Co., and has a steel capacity of 600,000 tons of ingots per year.

More recently, Acme has built steelmaking facilities at Riverdale, and with the pioneering spirit so often found in small companies, selected a new combination of operations to form a unique steelmaking process, the first of its kind in the Western hemisphere. The new facilities are based on continuous hot blast cupolas which supply molten metal to top-blown basic oxygen furnaces. The project also includes soaking pits, a blooming mill and a billet mill. The plant was designed to produce 450,000 tons of ingots per year, with provisions for future expansion to over 700,000 tons. Cost of the initial step was $35,000,000.

Raw materials for steelmaking consist of iron and steel scrap, pig iron, coke, limestone, fluorspar, burnt lime and roll scale. They arrive by rail, barge or truck. Metallics are unloaded by crane in the scrap aisle into storage or weighing bins at 15,000 tons capacity.

Nonferrous materials are dumped into a track hopper and moved by belt conveyor to overhead storage bins. Bin capacity for coke, limestone and fluorspar for the cupolas is 3000 tons. Bins for limestone, fluorspar, burnt lime and mill scale for the converters total 1800

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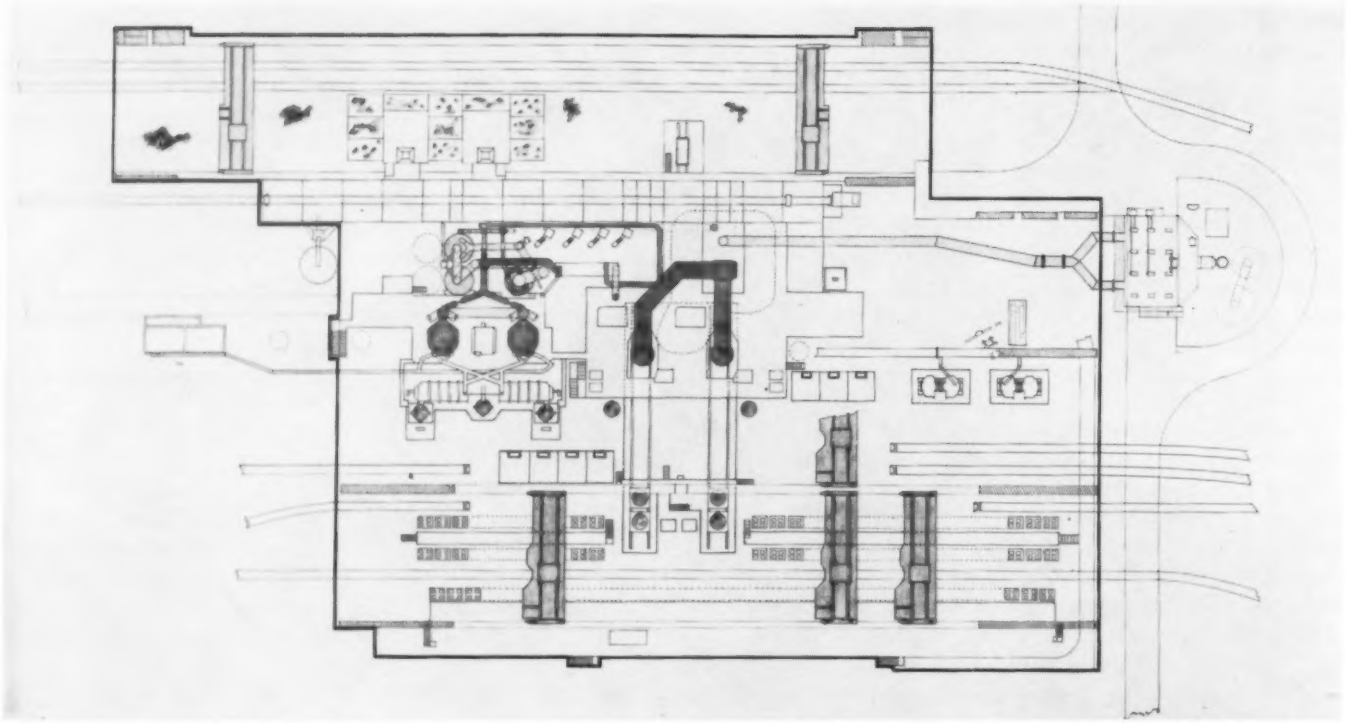


Plan of the new melt shop showing, from top to bottom, the scrap aisle, bin aisle, cupola-converter aisle, hot metal aisle and pouring aisle.

tons capacity. Inside bin capacity holds materials for eight to ten days' operation. The handling system is designed to unload material for 1.5 days of operation in 8 hr.

Additional ground and pit storage is available in the plant yard, where the various materials are stocked and reclaimed by locomotive crane.

Principal material requirements for initial operations run about as follows:

Cupolas (7 days per week, 3 shifts per day)

	Tons per month
Pig iron	15,000
Steel scrap	22,500
Coke	7,500
Limestone	2,000
Fluorspar	200

Converters (7 days per week, 2 shifts per day)

Hot Metal	35,700
Steel scrap	6,400
Burnt lime	2,000
Ferro manganese	200
Ferro silicon	100

This is predicated on 37,600 tons of ingots per month, resulting in 32,000 tons of slabs and billets.

The new melt shop consists of five adjacent aisles running 450 to 480 ft in length. The scrap aisle is 80 ft wide and is served by two 10-ton cranes. Next is the stock bin aisle, 28 ft wide, followed by the 80-ft cupola-converter aisle with eight cranes of various types, from 5-ton hoists for oxygen lances to 20-ton cranes for cupola charging. The hot metal aisle, with two 100-ton cranes, is 80 ft wide, and the pouring aisle, with one 100-ton crane and two 35-ton stripper cranes, is 80 ft wide.

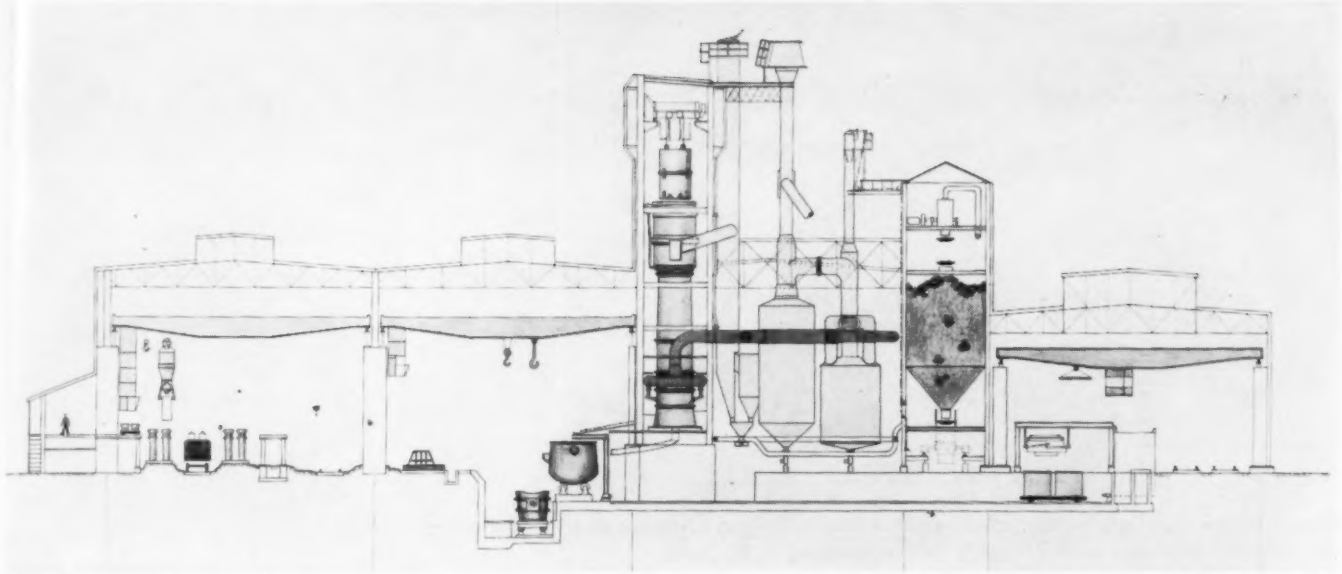
Metallics for the cupola charge are handled by magnet-equipped cranes which deposit the material into two 240-cu ft batch weigh hoppers. These hoppers dump into 360-cu ft charging buckets which are carried on transfer cars into the cupola-converter aisle. Coke, limestone and fluorspar are put into a 125-cu ft weigh hopper, from which the desired amounts are drawn into a motorized batch weigh lorry by means of vibrating feeders. The lorry in turn loads the drop-bottom charging buckets. Two 20-ton overhead cranes, one for each cupola, lift the loaded buckets and move them over the top of the cupolas. As a bucket is lowered onto a gas lock at the top of the cupola, a cover seals the top of the bucket. The doors at the bottom of the lock then open, allowing the charge to drop into the cupola. Thus, top pressure can be maintained as high as 12-in. water column and the escape of gas and dust is prevented.

The cupolas operate with a stock column about 40 ft high above the tuyeres. Stock level is controlled by a radioactive isotope stock line indicator. Charging equipment is designed to charge 12,000 lb of metallics with the required amount of coke, limestone and fluorspar once every 6.8 minutes to each cupola.

CUPOLAS

Molten metal for the steelmaking process comes from two continuous hot-blast cupolas 66 ft-8 in. high from bottom to the top of the water seal. The cupolas are placed on 48-ft centers and space is provided for a third unit. The shells of the cupolas are made of 2-in. plate for the base and 1½ in. plate for the base, body and stack. Shell diameters are 13 ft-3½ in. at the bottom, tapers in to 11 ft above the tuyeres, and to 10 ft at the top.

The cupolas are externally water-cooled in the melting zone and stack by five water spray rings. Thus, no lining is required in these sections. The only refractories in the cupolas are bottoms made up of 4½ in. of



Cross section through the cupola area of the melt shop. From left to right is the pouring aisle, hot metal aisle, cupola-converter aisle, bin aisle and scrap aisle.

fire-brick topped with 11½ in. of rammed basic material, and carbon block walls 9 to 22½ in. thick extending from the base plate up past the tuyeres.

Each carbon lining consists of 88 carbon blocks, laid four courses high. The blocks in the bottom course are 35 in. high, those in the other courses are 24 in. high. Block thickness decreases from bottom to top, giving a uniform inside diameter of 9 ft-6 in.

Each cupola is equipped with 12 water-cooled cast copper tuyeres seated in coolers. The tuyeres are 3½ to 5 in. in diameter, located about 8 ft above the base plate. The tuyeres extend 18 in. inside the inner face of the carbon lining and are angled five degrees down from the horizontal. A 30-in. inside diameter bustle pipe brings blast to the tuyeres.

Gas offtakes are located about 52 ft above the bottom plate. Just above the offtakes are water-cooled doors, which, with a water sealed cap, prevents gas leakage from the cupola top.

Cupola charges vary considerably, depending upon conditions. A typical charge might be 52 per cent steel scrap and 48 per cent pig iron and cast iron scrap, with 16 per cent coke, 5 per cent limestone and ½ per cent fluorspar. Cupola yield ranges above 90 per cent.

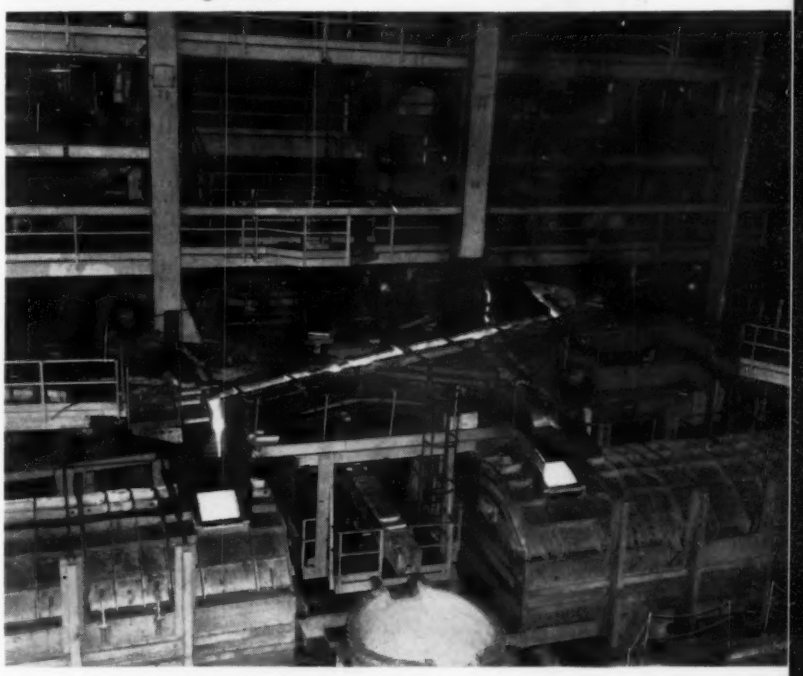
The cupolas are blown by four positive displacement, motor-driven blowers. Three blowers are rated at 14,700 cfm each, with 600-hp motors, one at 7700 cfm with a 300-hp motor. Their design pressure is 7.25 psi but operation up to 8.33 psi is possible. The blowers exhaust into a common blast main designed with valving for automatically controlled split-wind blowing. Blast for each cupola normally runs about 12,000 cfm.

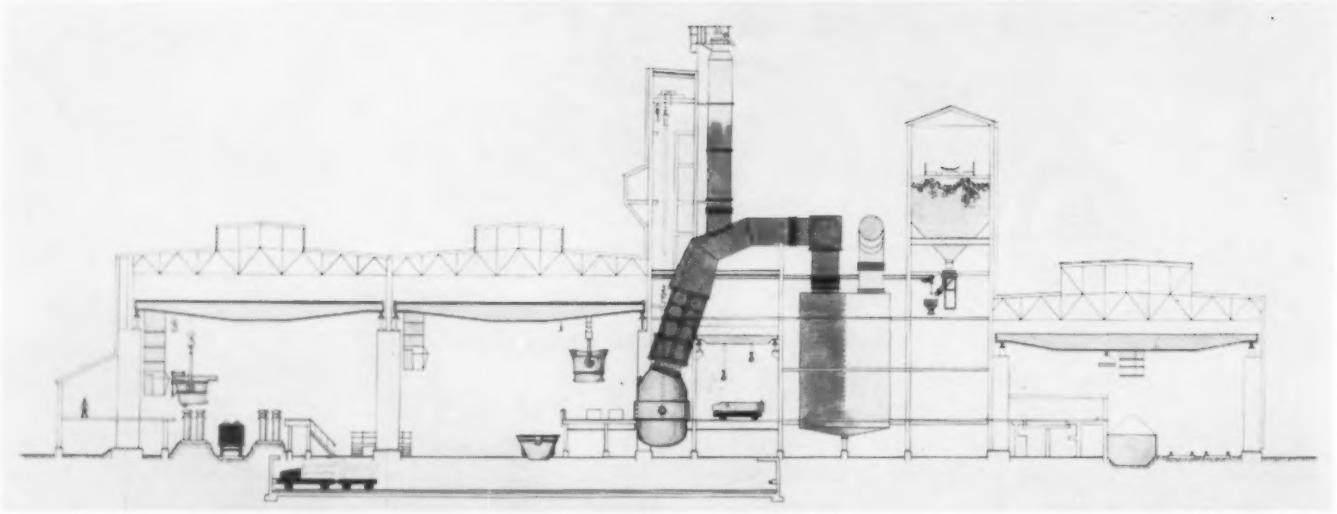
Gases leave the top of the cupola at about 250 F. They contain about 4 grains of solids per cu ft. These gases are thoroughly cleaned in a con.bination mechanical-electrical scrubbing unit composed of a dust catcher, cyclone whirler and washer tower, and an electrical precipitator of wet pipe type, with 200 eight-in. tubes. The clean gas is moved by a booster to a combustion chamber where the gas is burned. About one-half of the products of combustion are vented to the atmosphere, while one-half passes to the blast preheater. This is a metallic-tube heat exchanger designed to heat 40,000 cfm of air to 1200 F. Automatic control keeps the air temperature within five degrees of the desired temperature. The exchanger can also use natural gas if desired.

Water from the tower washer is put through a thickener 85 ft in diameter x 20 ft deep, designed to clarify 4500 gpm of water. Effluent from the thickener contains only 40 to 80 ppm of solids. Sludge is put through a vacuum type drum filter.

Each cupola can melt from 25 to 50 tons per hr, depending on the operating practice. A charge consisting principally of steel scrap holds down production. Maximum production is attained with a charge of pig iron and cast iron scrap, with foundry coke. The cupolas can be run with either basic or acid slag practice, as desired, giving flexibility of operation.

A flexible system of runners carries molten iron from the cupolas (back of row of columns) to the two 200-ton mixers in the foreground.





Cross section through the converter area of the melt shop, showing depressed track carrying the combination ladle car from the cupola-converter aisle (center) to the pouring aisle (left).

The cupolas are intended to operate continuously except for minor delays for repairs to iron spouts, slag separators, etc. Molten metal runs constantly into two 200-ton mixers placed in front of the cupolas. The mixers are gas-fired to maintain metal temperatures.

Slag from the cupolas is granulated at the skimmers and sluiced into a nearby pit. Slag volume runs about 185 lb per ton of metal.

Iron analyses from the cupolas will vary somewhat with the make-up of the charge. For a charge as previously given, the iron will contain approximately 3.7 per cent carbon, 0.6 to 0.7 per cent manganese, 0.2 to 0.3 per cent silicon, 0.08 to 0.12 per cent phosphorus and 0.04 to 0.045 per cent sulphur.

Iron is poured from the mixers into 75-ton hot metal ladles, which are moved by a 100-ton crane to the converters.

CONVERTERS

There are two identical 50/60-ton oxygen steel converters, located on 48-ft centers, with provisions for a third unit. The converter shells are 14 ft-6 in. inside diameter and 25 ft high with a dished bottom and an eccentric conical top section with a renewable tap hole section in the long side. The center section is made of 2-in. plate, the top and bottom sections of 1½-in. plate. The three sections are welded together under specifications for unfired pressure vessels. The top section carries a steel flange to which is bolted a renewable cast steel nose ring. The nose opening is 4 ft-6 in. in diameter inside the lining and is inclined 17 degrees from the horizontal. The opening is offset toward the scrap-charging and slagging side of the vessel.

Around the center section of each shell is a box-type trunnion ring built up of 1½ in. web plate with top and bottom flanges 5 in. thick. Forged steel trunnions, welded into the ring on each side, ride in bronze-bushed bearings 27 in. in diameter, supported on stand of welded steel plate 2, 2½ and 3 in. thick. Height from the base of the stand to the trunnion centerline is about 9 ft. All trunnions are water cooled.

The shell is lined with 27½ in. of tar dolomite, 4½ in. of magnesite brick, 4 in. of rammed basic material and 18 in. of rammed tar-dolomite brick. The bottom consists of 12 in. of magnesite brick and 21 in. of rammed tar-dolomite.

Each vessel is tilted by two 200-hp mill type motors with full magnetic reversing, plugging, armature shunt time-current controllers. These motors work through conventional reduction units, a special worm gear reducer and a 6-in. circular pitch cast tooth shrouded herringbone gear on one trunnion. The drive is capable of rotating the vessel through 360 degrees twice in one minute. Converter elevation is such that the vessel can be turned upside down with a ladle beneath.

A typical charge to a vessel for a 60-ton heat consists of approximately 120,000 lb of molten iron from the cupolas and 16,000 lb of cold steel scrap, with three to five per cent burned lime and perhaps fluorspar to the extent of two lb per ton of metal.

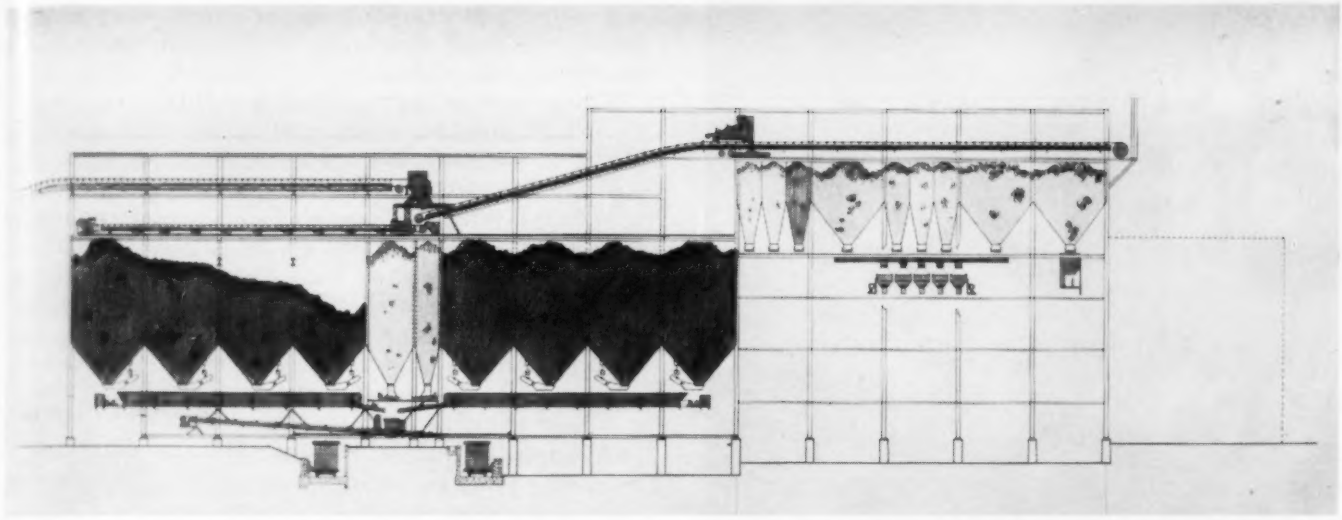
Scrap is brought from the scrap aisle in long, open-end boxes on a transfer car which accommodates two boxes. The box is lifted by a 10-ton double hoist crane and tilted over the converter mouth so the scrap slides into the vessel. Iron is poured into the vessel from the 75-ton ladles.

Fluxes and miscellaneous materials are drawn from overhead bins in the bin aisle into a monorail carrier which transports the materials and dumps them into the converter.

When the converter is charged, the oxygen lance is lowered by a 5-ton hoist to within four to six ft above the bath surface and the blow is begun. The lance is 43 ft long, and seamless tubing with a copper tip. A central tube within the lance conducts oxygen. Around this tube are two other concentric tubes which form a water passage to and from the tip.

Each converter is provided with a spare oxygen lance which is always hooked up to the oxygen and cooling water supplies, ready for service.

Oxygen pressure is maintained at 175 psi in the supply line. Oxygen flow during the blow may be varied between 3000 and 4000 cfm. Oxygen consumption runs about 1800 cu ft per ton of steel. The total heat time is about one hour, tap-to-tap, with about 30 min actual blowing time.



Longitudinal section through the bin aisle where nonmetallics are stored. Cupola section is to the left, converter section to the right.

Each converter is equipped with an automatic control system which regulates and totalizes the flow of oxygen to the converter. It will meter a given amount of oxygen to the vessel and then automatically stop the flow when this amount has been used.

The complete control system also regulates lance movement, lance cooling, converter tilting, ladle transfer car and dust collecting system. The various elements are so interlocked as to prevent operations when some element is out of sequence.

Fumes and dust blown out of the converter nose is collected by a water-cooled hood and led through a brick-lined duct to a collecting system. The gases first pass through a cooling tower 23 ft x 26 ft-6 in. x 40 ft high, fabricated of ¼-in. steel plate. The inlet side of the tower is lined with 3½ in. of gunned refractory. Water sprays in the tower reduce the temperature of the gases from about 1500 F to approximately 250 F.

From the tower, the gases flow through a 90-in., flue 230 ft long to a dry-type electrostatic precipitator. Steam jet blowers along the flue prevent dust accumulations. The precipitator is 54 x 30 x 60 ft high and contains 69,000 sq ft of plate area.

The converter collecting system operates under induced draft from a fan rated at 200,000 cfm, 6-in. water column at 250 F. The cleaning efficiency is guaranteed at 99.5 per cent.

When the blow is finished, the slag is poured off into a thimble and the steel then poured into a 75-ton ladle, both of which rest on a motor-driven transfer car running beneath the converter. The car is then moved across the hot metal aisle into the pouring aisle. Yields from the converter process average about 87 per cent.

A pouring platform is provided on the full length of each side of the pouring aisle. Stools are placed on the ground for the full length of both platforms, each stool accommodating four ingot molds. This provides enough molds so that each one is normally used once every 12 hours.

Serving the pouring aisle are two 35-ton traveling stripper cranes and, between them, a 100-ton ladle crane.

Steel produced ranges from low carbon rimmed grades to high carbon killed grades. Three mold types are used: 21¼ x 23¼-in. and 25½ x 27½-in. big-end-down open tops, and 24½ x 26½-in. big-end-down hot tops. The open top molds are 82 in. high, and by varying pouring heights from 62 to 78 in., ingot weights of 9870 to 12,270 lb are attained. The hot topped molds are 74¼ or 83½ in. high, giving gross weights of 8770 and 11,300 lb.

Approximately 80 per cent of the steel produced goes into big-end-down, open top molds, and only 20 per cent into hot topped molds.

A platform for the preparation of hot tops is located in a lean-to at the side of the pouring aisle. This platform is served by small cars which carry hot tops across the pouring platform from the preparation lean-to.

Molten iron from the mixers is transported in 75-ton hot metal ladles and poured into one of the converters.

View of control panel for the oxygen converters. Each converter has an automatic control system for the flow of oxygen.

A laboratory located near the converters serves these units and the cupolas. It contains a direct-reading spectrometer, sample preparation equipment and facilities for conventional carbon and sulphur determinations.

OXYGEN PLANT

Oxygen of 99.5 per cent or higher purity is provided from a plant located near the melt shop. This plant furnishes 116 tons of oxygen per day which is produced by low temperature fractional distillation of air. This is a four-step process consisting of compression, cooling, liquefaction and distillation of air into oxygen and nitrogen.

The gaseous oxygen is stored in a 240,000-cu ft bank of 37 high pressure cylinders 80 ft long. The melt shop draws on this bank through a pressure reducing station which supplies oxygen at 200 psi. A portion of the oxygen is diverted as liquid to a storage tank which has a capacity of 3,000,000 cu ft gaseous equivalent. This liquid can be vaporized and used as required during routine maintenance shutdowns of the oxygen plant. Total storage amounts to enough oxygen to keep the steel plant operating for about 50 hours.

BLOOMING MILL

After the ingots are stripped, they are put into two refractory-lined transfer cars which are then moved to the soaking pits or to an ingot storage area.

There are 12 soaking pits arranged in three blocks of four pits each, forming a single row in line with the mill. Each pit is 20 ft long x 8 ft wide x 13 ft-6 in. and is fired by one combination burner which will handle natural gas or fuel oil, located in the top of one end wall. Maximum fuel input is 20,000,000 Btu per hr.

Combustion air, furnished by one 16,000-cfm fan for each block, is not preheated, but provisions were made for future installation of recuperators when desired. Each battery is served by a 150-ft stack, 5 ft inside diameter.

Each pit is designed to heat a charge of 23 ingots (about 55 tons total) from cold to 2350 F in 10 to 11 hr. Estimated fuel consumption, without recuperation, is about 1,200,000 Btu per ton.

Each pit is equipped with automatic controls for pit

When the blow is finished, the steel is poured into a 75-ton ladle resting on the transfer car below. The car is then moved to the pouring aisle, where the ladle is handled by crane for teeming.

A pouring platform is provided on the full length of each side of the pouring aisle. Stools, each accommodating four molds, are placed on the ground in front of these platforms.

temperature, fuel-air ratio and pit pressure, Fuel flow is recorded and totalized. Instruments and controls for each battery are grouped in a modern enclosed control house.

When ready for rolling, ingots are drawn from the pits by a 15-ton fixed-tong pit crane and carried to the mill in a tilting-pot, front-discharge buggy. An auxiliary 10-ton hanging-tong pit crane is also provided.

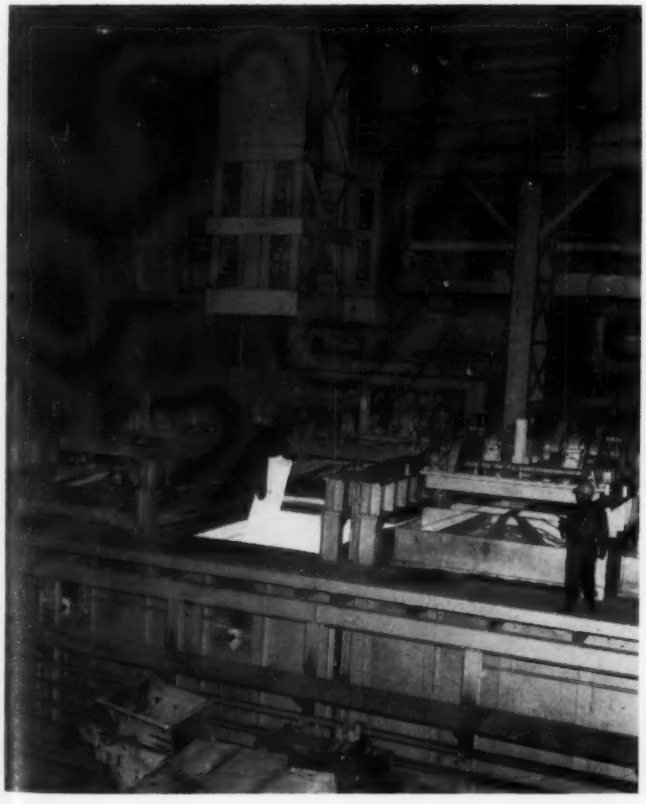
The approach table and entry table extend for about 131 ft to the mill stand.

The blooming mill is a 35-in. two-high reversing unit, with cast alloy steel rolls of 35-in. collar diameter and 80⅞ in. body length running in composition bearings. The rolls carry pass grooves of 3 1/16, 3¾, 7½ and 12 in., and a 33 3/16 in. bullhead. The top roll is balanced by a counterweight, and is moved up and down by 12-in. mill screws of 1½-in. pitch. The screwdown mechanism is driven by two 75-hp mill type motors operated under magnetic control. Roll lift speed is 204 in. per min and the maximum opening is 30¼ in. at the bullhead. Housing posts have a 400-sq in. sectional area.

The mill is driven by a 6500-hp, 0/60/140 rpm, 700-volt d-c motor working through herringbone pinions of 35-in. pitch diameter, 50-in. face. This motor draws power from a motor-generator set consisting of two 3000-kw, 700-volt d-c generators, a 137,000-lb steel plate flywheel 180 in. in diameter, and a 4500-hp, 360-rpm, 12,000-volt induction motor. The drive provides a normal operating torque of 400,000 ft-lb and a maximum torque of 1,138,000 ft-lb.

In the mill, the ingot is handled by side guard manipulators, with a finger lift for turning on the entry side. The manipulators are driven through rack and pinion by four 35-hp mill type motors. The lift finger is operated by a 50-hp mill type motor. These motors are provided with magnetic control. Mill scale is sluiced to a scale pit.

Twelve soaking pits heat ingots for rolling on the blooming mill. When an ingot is ready, it is drawn by the pit crane and placed in the ingot buggy shown in the foreground.



The main drive motor and its motor-generator set, controls and switchgear are located in a motor-room approximately 158 ft long x 69 ft wide. The rotating units are cooled by forced air, with the air being drawn into the basement, passed through a filtering system, and blown up through the machines. Two air compressors are also located in the motor room.

Leaving the mill, steel passes over a succession of tables to a shear 187 ft from the mill. This shear is operated through a clutch by a 250-hp, 900-rpm a-c motor under magnetic control. The shear is capable of cutting sections of hot steel up to 80 sq in. Crops are chuted to a pit below the shear and later removed by magnet crane and placed in railroad cars.

A closed-circuit television camera is installed at the shear so the operator can see the back ends of the steel, enabling him to adjust cuts to attain maximum yield.

After shearing, slabs are removed from the table and transported over a hot bed about 70 ft long to an adjacent slab yard.

From the shear, blooms may also proceed straight ahead over tables to the billet mill.

The blooming mill normally receives ingots 21¼ x 23¼ in., 8520 lb or 25½ x 27½ in. 12,270 lb. At speeds up to 1200 fpm, it reduces these to slabs ranging from 8 x 3 in. to 22¼ x 2½ in. or to blooms of 6 x 6 in. to 9¼ x 6 in. Product is about equally divided between slabs and blooms. The mill rolls at rates of 60 to 120 tons per hr, depending on the size of product delivered.

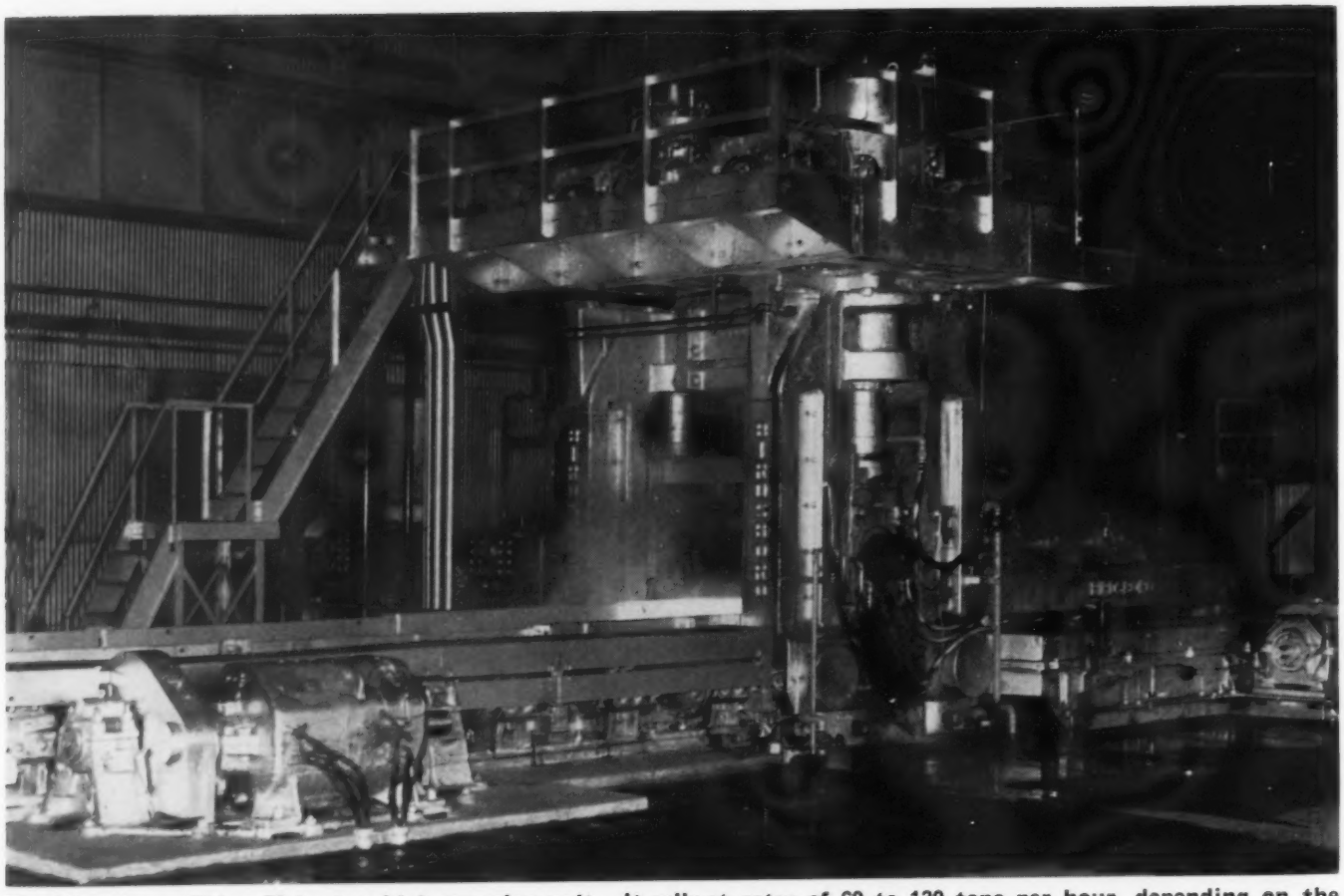
BILLET MILL

In line with the blooming mill and about 100 ft beyond the hot bed is the first stand of the billet mill. This mill has the following characteristics:

Stand No.	1	2	3
Type	3-high	3-high	2-high
Roll diameter, in.	24	21	24
Rolled body length, in.	48	48	48
Distance from preceding stand, ft-in.	..	171–0	135–0
Motor hp	2500	2000	1200
Motor rpm	240	180	120
Motor type	Slip ring	Syn.	Syn.
Gear ratio	2.92	2.0	Direct
Roll rpm	82	90	120

Roll necks run in composition bearings. Pinions are of 26-in. face, 24 and 21-in. pitch diameters. Roll adjustments are made by manually operated screws, 4½ in. in diameter, 1¼-in. pitch. Pinions and reduction gears are lubricated by a central circulating oil system.

The three-high stands are not equipped with tilting tables. Instead, on their down-mill sides, sloping pieces of specially shaped channels rest on the upper pass level. As the steel moves down-mill through the lower pass level, it moves under the hinged channels. When the table rolls bring the steel back, it moves up the channels into the upper pass level. As the steel leaves the upper pass level on the up-mill side, it drops to the mill table.



The blooming mill is a 35-in. two-high reversing unit. It rolls at rates of 60 to 120 tons per hour, depending on the size of product delivered.

No. 3 hot strip mill, put into operation in 1929, has 14 two-high stands. It produces strip $^{3}/_{4}$ in. to 8 $^{5}/_{16}$ in. wide, No. 18 gage and heavier, at an average rate of 26 tons per hour.

TABLE I
Hot Strip Mill Data

Stand	Roll diam, in.	Roll body length, in.	Distance from preceding stand, ft-in.	Motor data: Hp	Voltage	Type	Rpm	Gear ratio	Roll, rpm	Roll face speed, fpm
No. 1 hot mill										
No. 1 rougher	12 3/4	15	...					17.37	11.34/18.7	38.1/62.8
No. 2 rougher	13 1/16	15	4-5					11.07	17.8/29.3	45.8/75.6
No. 3 rougher	11 1/8	15	3-10			Wound		7.38	26.7/44.0	78/128.5
No. 4 rougher	10 1/2	15	3-5	900	2200	rotor	197/325	5.18	38.0/62.7	104.5/172.5
No. 5 rougher	12 3/4	15	3-3			induction		3.88	50.8/83.8	169/279.8
No. 1 vertical edger	12	..	3-3/4					3.03	65/107	205.5/337.9
No. 6 rougher	14	15	3-11/4					2.22	88.5/146	330.5/545
No. 2 vertical edger	12 9/16	..	20-5	100	250	d-c	300/600	3.32	90.2/180.4	296.5/593
No. 7 finisher	10 1/2	12	16-1					0.97	165/248	453/682
No. 8 finisher	10 3/4	12	8-6			Wound		0.7	229/344	645/968
No. 9 finisher	11 1/16	12	7-0	1800	2200	rotor	160/240	0.516	310/465	899/1348
No. 10 finisher	11 5/16	12	6-6			induction		0.385	415/622	1231/1845
No. 11 finisher	11 1/16	12	6-6					0.296	541/811	1563/2342
No. 2 hot mill										
No. 1 horizontal edger	12/15 1/4	24	...					20.43	34.5	108/138
No. 2 rougher	19	24	15-5 1/2					20.43	34.5	168
No. 3 rougher	19	24	16-7 1/2	1500	2300	Induction	705	14.0	50.4	252
No. 4 horizontal edger	11/16 3/4	24	33-0					7.42	95	282/414
No. 5 rougher	19 1/2	24	30-0					9.67	72.9	372
No. 6 vertical edger	15	23 1/4	36-7	100	600	d-c	360/900			
No. 7 rougher	19 7/8	24	8-0					7.42	95	492
No. 8 vertical edger	15	23 1/4	66-0	100	600	d-c	260/900			
No. 9 finisher	15 1/2	24	8-0	1500	600	d-c	200/400	2.62	76.3/152.6	306/612
No. 10 finisher	15 5/8	24	18-0	1800	600	d-c	185/370	1.84	100/200	408/816
No. 11 finisher	15 7/8	24	77-0	1800	600	d-c	125/250	Direct	125/250	518/1036
No. 12 finisher	16	24	18-0	1800	600	d-c	125/250	Direct	125/250	523.5/1047
No. 13 finisher	16 1/4	24	18-0	1800	600	d-c	185/370	Direct	185/370	786/1572
No. 14 finisher	16 1/2	24	18-0	1800	600	d-c	185/370	Direct	185/370	798/1596
No. 3 hot mill										
No. 1 vertical edger	26	..	...	150	600	d-c	400/1200	74.1	5.39/1619	36.7/110.4
No. 2 rougher	13 1/4	16	5-3	600	600	d-c	400/1000	27.68	14.45/36.12	50.1/125
No. 3 rougher	13 1/4	16	6-0					19.15	20.88/52.21	72.5/181
No. 4 vertical edger	26	..	8-5	150	600	d-c	400/1200	31.4	12.73/38.21	86.7/260
No. 5 rougher	13 7/8	16	3-3	600	600	d-c	450/900	11.33	37.7/79.43	137/288
No. 6 rougher	13 7/8	16	6-0					7.84	63.92/114.79	232/417
No. 7 vertical edger	26	..	8-5	150	600	d-c	400/1200	13.72	29.15/87.46	198/595
No. 8 rougher	14	16	5-3	600	600	d-c	450/900	4.54	99.1/198.2	363/726
No. 9 vertical edger	26	..	8-5	150	600	d-c	400/1200	7.7	51.9/155.8	354/1062
No. 10 finisher	11 1/2	16	39-3	600	600	d-c	450/900	3.133	143.6/287.2	432/865
No. 11 finisher	11 3/4	16	8-8	600	600	d-c	450/900	2.35	191.4/382.9	589/1178
No. 12 finisher	12	16	8-8	700	600	d-c	264/595	Direct	264/595	829/1870
No. 13 finisher	12 3/8	16	8-8	800	600	d-c	382/908	Direct	382/908	1237/2941
No. 14 finisher	12 5/8	16	8-8	800	600	d-c	382/908	Direct	382/908	1262/3001

The billet mill receives 6 x 6-in. or 9 1/4 x 6-in. blooms, 30 to 33 ft long, and reduces them to squares 1 3/4 to 2 1/4 in. or slabs up to 8 5/16 x 2 1/8 in. Billets are rolled with five passes in the first stand and three or five passes in the second stand, depending on finished size. Slabs are usually given three passes in the first stand, three in the second stand and one in the third stand.

Leaving the last stand of the mill, the steel passes over a table provided with three swing-frame 42-in. hot saws to two chain-type cooling beds 60 ft long x 30 ft wide. From the discharge ends of the beds, a roller table approximately 270 ft long connects back into the slab yard.

Extra stands are provided which can be set up for roll changes and then substituted for the working stands when the change is to be made, thereby reducing downtime.

An inspection and scarfing area in the slab yard serves both the blooming mill and the billet mill. Following this procedure, slabs and billets are bundled, banded and sent to the stock yards of the hot strip mills.

HOT STRIP MILLS

Prior to the installation of the steelmaking facilities and blooming mill, production at Riverdale centered chiefly on three hot strip mills with a total capacity of 590,000 tons of hot rolled strip per year.

Details of these mills are given in Table I and in the following:

No. 1 mill—Put into operation in 1919. 13 stands. Uses billets 1 5/8 in. square or up to 2 1/8 x 3 1/4 in., 27 to 29 ft long. Produces strip 0.025 to 0.05 in. thick in widths of 2 to 3 15/16 in., at average rate of 17 tons per hr. All product is coiled.

One heating furnace, single zone continuous, recuperative hearth 25 x 31 ft. Natural gas or producer gas. Production, 23 tons per hr.

Rougher and finisher roll necks run in composition bearings, edger rolls in babbitted bearing.

Main drive induction motors arranged in Scherbius systems for variable speed. The 900-hp rougher drive is regulated by a motor-generator set consisting of one

TABLE II
Cold Mill Data

Stand	Backup roll diam, in.	Backup roll diam, in.	Roll body length, in.	Distance from preceding stand, ft-in.	Motor data				Gear ratio	Roll rpm	Roll face speed, fpm
					Hp	Voltage	Type	Rpm			
Reversing cold mill											
Mill stand reels (2)	14½	33	29	..	1000 (2) 250	600 250	d-c d-c	500/800 300/1200	2.44	205/327	780/1240
Tandem cold mill											
No. 1 stand	14½	29	22	..	400	600	d-c	350/1050	3.32	107/310	396/1188
No. 2 stand	14½	29	22	14-0	500	600	d-c	350/1050	2.51	140/420	530/1590
No. 3 stand	14½	29	22	14-0	500	600	d-c	350/1050	1.963	177/534	676/2028
No. 4 stand	14½	29	22	14-0	500	600	d-c	350/1050	1.548	226/673	858/2574
Reel					150	750	d-c	300/1200			
Tandem cold mill											
No. 1 stand	14½	33½	22	..	1250	600	d-c	90/270	Direct	90/270	342/1025
No. 2 stand	14½	33½	22	14-0	1250	600	d-c	125/375	Direct	125/375	475/1423
No. 3 stand	14½	33½	22	14-0	1250	600	d-c	200/500	Direct	200/500	760/1900
No. 4 stand	14½	33½	22	14-0	1250	600	d-c	300/670	Direct	300/670	1140/2545
No. 5 stand	14½	33½	22	14-0	1250	600	d-c	400/800	Direct	400/800	1520/3040
Reel					300	350	d-c	150/750			
Cluster Mill											
Mill stand reels (2)	1⅛	6.3, 3.6, 2.0	14	..	500 (2) 300	600 250	d-c d-c	850/1270 300/1200	Direct	2720/4100*	800/1200
Tandem cold mill											
No. 1 stand	16½	..	22	..	250	250	d-c	400/800	26.6	15/30	65/130
No. 2 stand	16½	..	22	17-8	250	250	d-c	400/800	22.0	18/36	78/156
No. 3 stand	16½	..	22	34-0	250	250	d-c	400/800	22.0	18/36	78/156
No. 4 stand	16½	..	22	17-8	250	250	d-c	400/800	19.0	21/42	90/180
Single stand cold mill											
Mill stand	5¾	19	18	..	200	250	d-c	400/800	2.89	138/272	207/408
Single stand skin pass mills											
Mill stand	16½	..	22	..	250	250	d-c	400/800	19.0	21/42	90/180
Mill stand	12½	..	22	..	150	250	d-c	400/800	13.3	30/60	98/196
Mill stand	12½	..	16	..	150	250	d-c	400/800	13.3	30/60	98/196
Mill stand	19	..	29	..	150	250	d-c	640/1040	8.23	78/125	390/625
Mill stand	13½	..	22	..	150	250	d-c	400/800	8.0	50/100	176/353

* Includes ratio of driven roll diameter to work roll diameter.

170-kva, 133-volt generator and a 230-hp, 2200-volt induction motor.

Regulation for the 1800-hp finisher drive comes from a 270-kva, 205-volt generator driven by a 335-hp, 2200-volt induction motor.

Mill discharges through water-cooled trough and vibrator and over variable speed apron conveyor to vertical coilers. A muffle conveyor provides controlled cooling of coils.

Mill rated at 122,000 tons per yr.

No. 2. mill—Put into operation in 1926. 14 stands. Uses billets 3 to 22⅛ in. wide, 2½ to 3 in. thick, 10 ft long. Produces strip 3 to 11 in. wide in No. 16 gage, 3 to 17 in. wide in No. 14 gage, and 3 to 22 in. wide in heavier gages, at average rate of 41 tons per hr. About 70 per cent of the product is coiled, 30 per cent flat.

Three heating furnaces, continuous, recuperative, hearth 41 ft-3 in. x 12 ft. Natural gas or oil. 21 tons per hr each.

Finisher roll necks run in composition bearings, edger rolls in babbitted bearings; roughers, some babbitted, some composition.

Finishing stands driven at adjustable speeds by d-c motors under adjustable voltage control, using two motor-generator sets, each consisting of two 1000-kw, 600-volt d-c generators and a 2850-hp, 2300-volt, 900-rpm synchronous motor.

Mill discharges over runout table under variable frequency control either to double hot bed about 250 ft long or to horizontal hot coiler. Cold run on each side of hot bed contains shear and horizontal coiler.

Mill rated at 288,000 tons per year.

(As this is being published, No. 2 hot strip mill is being replaced by a new 36-in. mill consisting of a two-high reversing roughing stand and a continuous train of four-high finishing stands. The new mill will produce strip up to 31 in. wide in coils weighing up to 450 lb per in. of width.)

No. 3 mill—Put into operation in 1929. 14 stands.

The five-stand tandem mill is a 14½ in. and 33½ in. × 22 in. unit with a capacity of 7800 tons per month. It produces strip 0.007 to 0.05 in. thick in widths up to 19 in.

Uses billets 1⅝ to 8 5/16 in. wide, 1⅝ to 2½ in. thick, 28 to 30 ft long. Produces strip ¾ to 8 5/16 in. wide, No. 18 gage and heavier, at average rate of 26 tons per hr. Product is 80 per cent coiled, 20 per cent flat.

One heating furnace, single zone, side charge, side discharge, continuous, recuperative, hearth 33½ x 33½ ft. 40 tons per hr.

Rougher and finisher roll necks run in composition bearings, edger rolls in roller bearings.

Entire mill driven by direct current, with adjustable voltage control. Power provided by one motor-generator set composed of two 2000-kw, 600-volt generators, a 300-kw, 250-volt generator, a 100-kw, 250-volt generator and a 250-kw, 125-volt generator, all driven at 514 rpm by a 6350-hp, 12,000-volt synchronous motor.

Mill may discharge either through pinch rolls and vibrator, over apron conveyor to vertical coilers, or over runout and hot bed to three cold run tables.

This four-stand 14½ in. and 29 in. x 22 in. cold mill can turn out strip 0.008 to 0.069 in. thick in widths up to 18½ in. It has a monthly capacity of 7000 tons.

Coils are annealed in single stack, radiant tube, portable annealing furnaces. The furnaces are fired with natural gas or butane, under automatic temperature control.

Mill rated at 180,000 tons per yr.

COLD ROLLING AND FINISHING

The cold mill division at Riverdale provides facilities for pickling, cold reduction, annealing, temper rolling, slitting, shearing, inspecting and packaging of strip products.

Coils received from the hot mills may be processed through three combination scale-breaking and buttwelding lines. These lines build up coils to a maximum of 500 lb per inch of width for further processing.

Pickling is performed on three multiple strand continuous picklers with a combined capacity of 30,000 tons per month. Each pickler has two 90-ft long acid tanks, rinsing and drying facilities and eight mandrel type coilers. This multiple coiler system enables each line to pickle from 8 to 14 strands at any one time. Acid concentrations range between 6 and 18 per cent with the overflow piped to a batch pickler used to pickle cut-to-length material. Maximum speed of the continuous picklers is 80 fpm. Coil ends are joined together by means of steel hooks to maintain continuity.

Cold reduction is performed on four 4-high mills, a cluster mill and a 2-high mill. The 4-high mills consist of a 3000-fpm, 5-stand tandem mill, a 2500-fpm, 4-stand tandem mill, a 1500-fpm reversing mill and a 500-fpm single stand mill. The cluster mill operates at a maximum of 1200 fpm. The 5-stand mill is equipped with a noncontact gage between No. 1 and No. 2 stands which provides automatic screwdown control of No. 1 stand. The reversing mill and the cluster mill are each equipped with noncontact gages which also provide automatic screwdown control.

TABLE III

Mill	Maximum width, in.	Finished gages, in.	Per cent reduction	Capacity, tons per month
Reversing mill	27 1/2	0.008/0.20	85	3000
Four-stand tandem	18 1/2	0.008/0.069	70	7000
Five-stand tandem	19	0.007/0.05	85	7800
Cluster mill	13	0.003/0.10	85	700
Two-high tandem	20	0.035/0.325	50	4000
Single stand	16	0.01/0.05	40	1000
Skin mill	20	0.008/0.156		
Skin mill	14	0.008/0.125		
Skin mill	13	0.008/0.125	.....	6000
Skin mill	18	0.008/0.062		
Skin mill	27 1/2	0.008/0.125		

Temper rolling is performed on five 2-high single stand mills. In addition, the 4-stand 2-high mill is also used for temper rolling. Details of these mills are given in Table II.

Capacity data for these mills is contained in Table III.

Coil annealing is done in 11 single stack, radiant tube, portable furnaces with 32 bases. Cut-to-length material is annealed in six stationary rectangular furnaces with removable bases and one portable removable furnace with three bases. The cut-to-length furnaces are direct fired. Protective atmosphere is supplied by four DX gas generators with a combined capacity of 14,000 cfhr and two NX gas generators with a combined capacity of 6000 cfhr. All furnaces are fired with natural gas or butane gas under automatic temperature controls. Temperatures range between 1150 and 1325 F. Total cycle time ranges between 8 to 15 hr heating, 3 to 20 hr soaking and 12 to 96 hr cooling. Monthly capacity is 7500 tons.

A normalizing furnace is used to normalize cut-to-length material as required. The over-all length of the furnace is 103 ft and the width is 9 ft. The furnace has a 33-ft heating zone, a 13-ft high-temperature cooling zone and a 33 ft low-temperature cooling zone. Material is conveyed through the furnace by means of a walking beam conveyor at speeds of two to four fpm. Capacity is five tons per hour. The furnace is direct fired and uses natural gas or butane as a fuel.

Finishing equipment also includes some miscellaneous machines as set forth in Table IV. In addition, the manufacturing departments contain 16 slitters that provide a total capacity of 15,000 tons per month.

Two hot dip galvanizing units and six electrolytic galvanizing lines provide capacity for coating 2000 tons and 8300 tons per month of the respective types. ▲

TABLE IV
Miscellaneous Finishing Equipment

Kind of lines	Slitters	Cut-up lines	Edge roller	Sheet levelers	Butt-welders	Coil leveler	Rewind line
No. of lines	7	6	1	3	3	1	1
Gages handled, in.	0.002/0.40	0.008/0.25	0.014/0.25	0.02/0.3	0.042/0.2	0.042/0.2	0.003/0.06
Widths handled, in.	1/2 to 37	1/2 to 27	1/4 to 3	5/8 to 28	2 to 26	3 to 18	3 to 30
Lengths handled, in.	..	6/342	14/422	36/168	..	..	..
Monthly capacity, tons	13,000	3000	500	5000	18,000	5000	3500

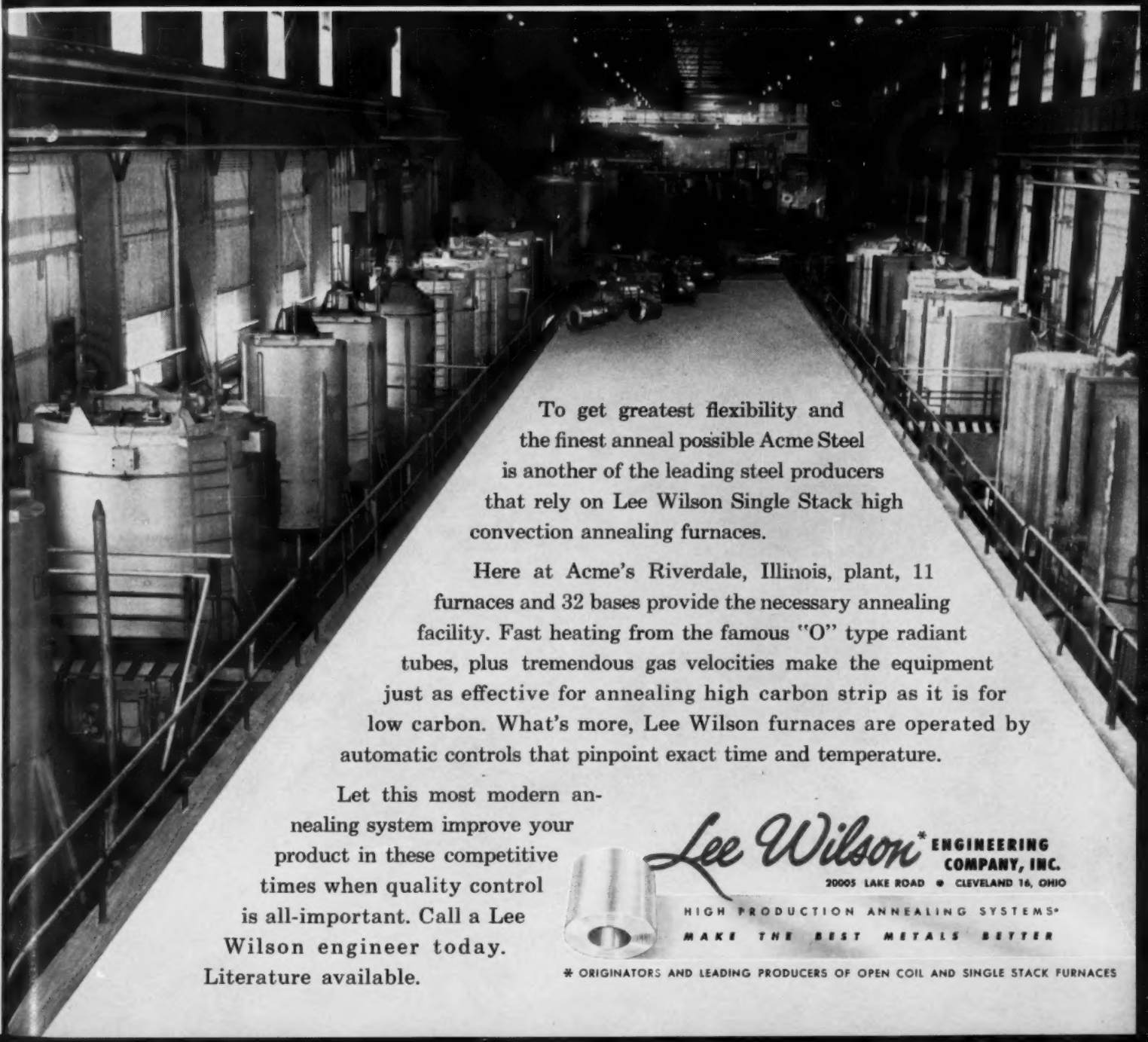
Acme Steel, too

. . . relies on

Lee Wilson

high convection

single stack annealing furnaces



To get greatest flexibility and the finest anneal possible Acme Steel is another of the leading steel producers that rely on Lee Wilson Single Stack high convection annealing furnaces.

Here at Acme's Riverdale, Illinois, plant, 11 furnaces and 32 bases provide the necessary annealing facility. Fast heating from the famous "O" type radiant tubes, plus tremendous gas velocities make the equipment just as effective for annealing high carbon strip as it is for low carbon. What's more, Lee Wilson furnaces are operated by automatic controls that pinpoint exact time and temperature.

Let this most modern annealing system improve your product in these competitive times when quality control is all-important. Call a Lee Wilson engineer today. Literature available.

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HIGH PRODUCTION ANNEALING SYSTEMS*

MAKE THE BEST METALS BETTER

* ORIGINATORS AND LEADING PRODUCERS OF OPEN COIL AND SINGLE STACK FURNACES

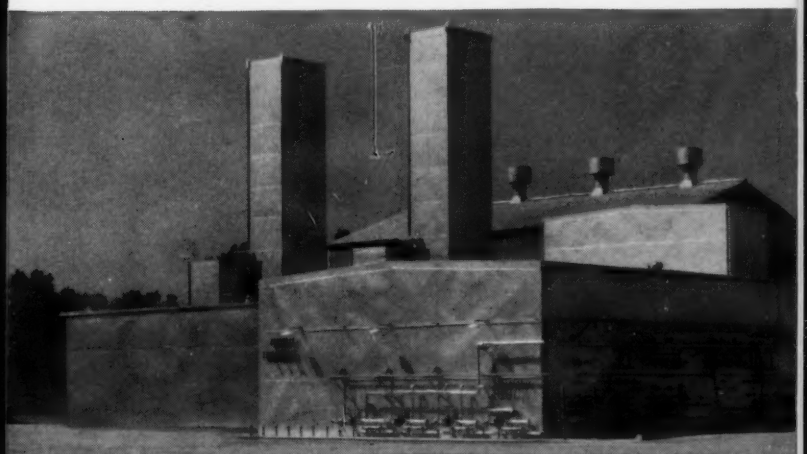
HOW ACME STEEL MADE HISTORY W

Y WITH OXYGEN

In mid-1959, when the first heat was poured at Acme Steel Company's new 35 million dollar plant at Riverdale, Illinois, steel was made for the first time in North America by the combination of continuous hot blast cupolas and top blown oxygen converters. New speed and economy were brought to the production of high quality steel . . . and Acme's finishing mills were assured a supply of ingots at lower cost to serve an expanding list of customers.

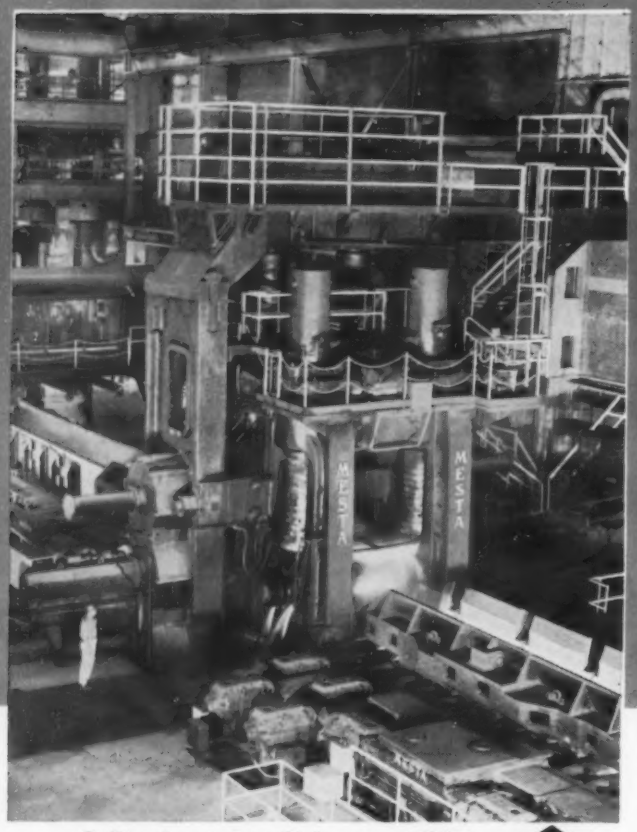
A striking highlight of Acme's accomplishment is that just a few years ago the company did not produce any of its own steel! Semi-finished steel for its hot and cold rolled products was all purchased, subject to constantly changing prices and delivery schedules. When the company planned to integrate its operations, a key factor was a reliable, low-cost supply of high purity oxygen for the converters. Acme called on Air Products for engineering and cost studies, and made the decision. As a result Air Products installed directly adjacent to the mill a generating facility that can supply Acme with more than 80 million cubic feet of high purity oxygen per month, at no capital investment to Acme. Acme's converters get all the oxygen they need at the low cost that makes this new process feasible.

Helping the steel industry put oxygen to work profitably has been Air Products business for over 20 years. On-site generating facilities, pioneered and perfected by Air Products, have made oxygen an easy-to-get utility, sliced its cost by 80%. Progressive steel companies across the nation are taking advantage of Air Products long experience and up-to-date technical services. Let's talk about *your* needs. Air Products, Inc., Allentown, Pa.



Air Products oxygen facility supplying Acme Steel Co.

Air Products
...INCORPORATED



Rolling Ingots into Slabs on a MESTA
45" x 90" Universal Reversing Slabbing Mill

MESTA

DESIGNERS AND BUILDERS
OF COMPLETE STEEL PLANTS

ROLLING MILLS FOR FERROUS AND NON-FERROUS METALS

CAST AND FORGED MILL ROLLS

AUXILIARY MILL AND PROCESSING EQUIPMENT

HEAVY DUTY MACHINE TOOLS

HYDRAULIC FORGING PRESSES

IRON AND STEEL CASTINGS

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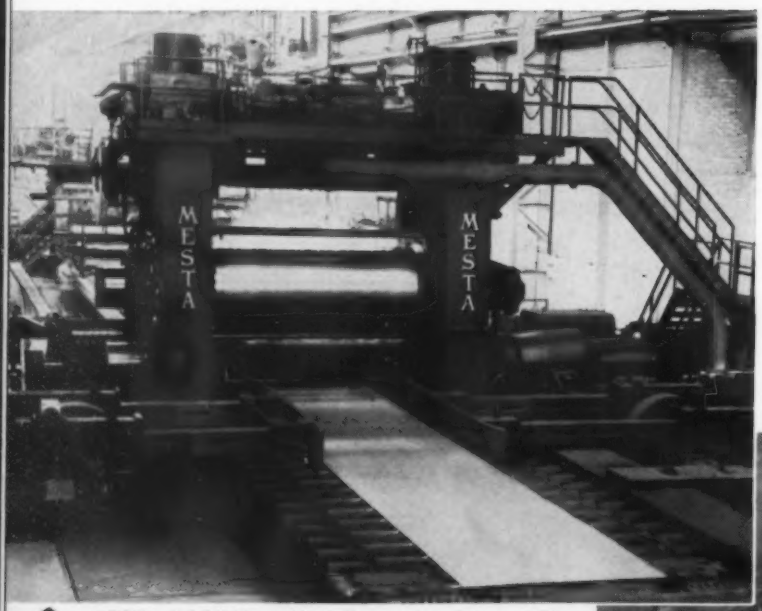
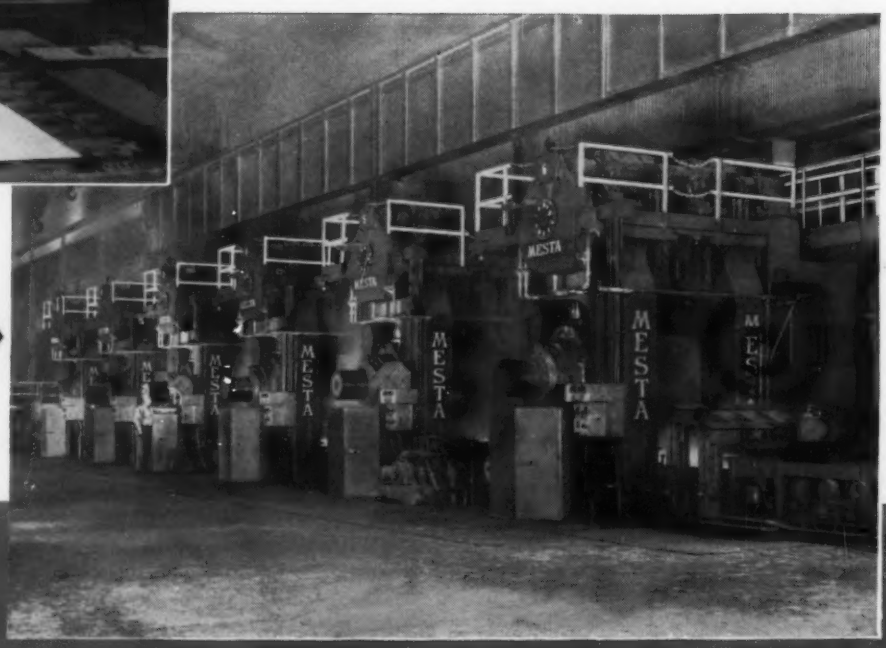
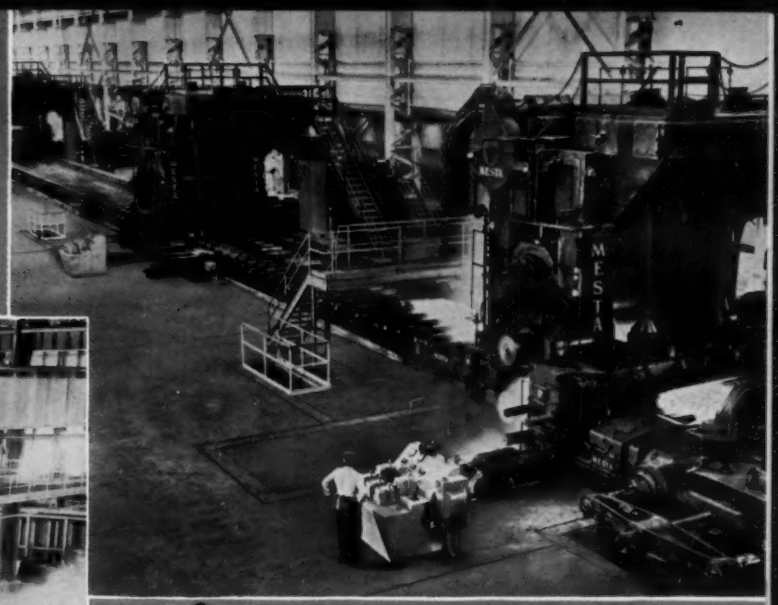


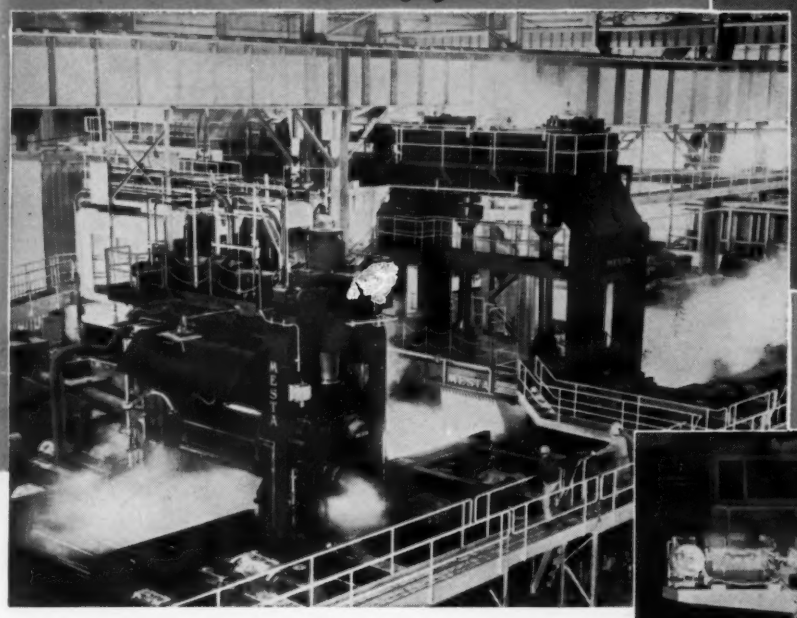
MESTA 132" Four-High Reversing Plate Mill



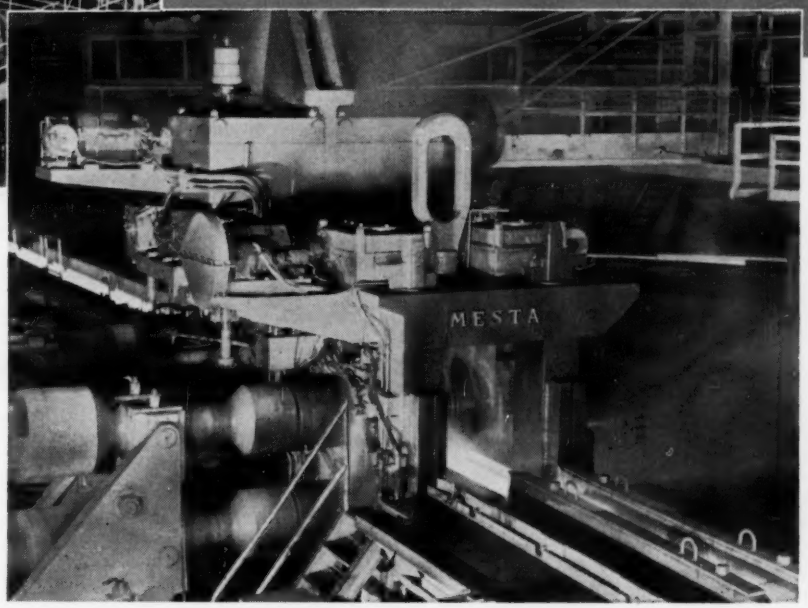
Six Finishing Stands with Three Vertical Edgers
on the MESTA 44" Four-High Hot Strip Mill



Rolling Slabs and Plates on the MESTA 140" Four-High Reversing Mill and Vertical Edging Mill

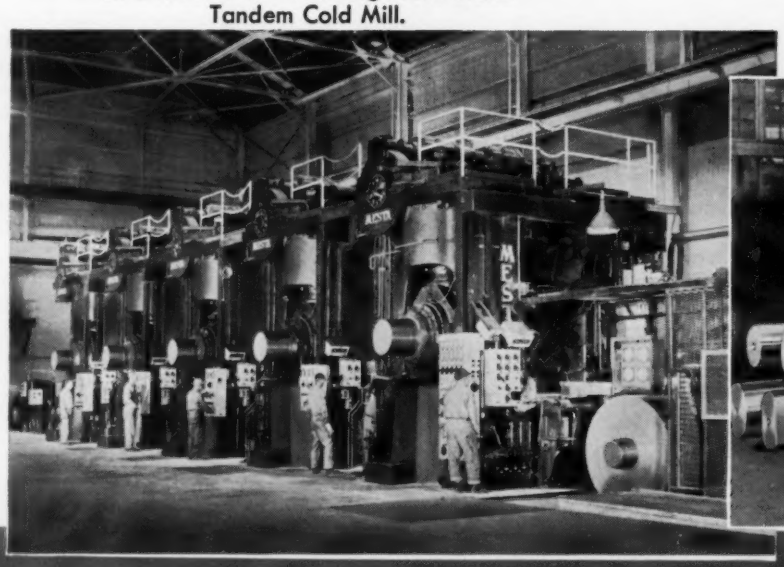


MESTA Continuous Hot Strip Mill Universal Roughing Stands Rolling Strip Steel



MESTA Universal Structural Mill Rolling Wide Flange Beams on the 44" Universal Stand and the 34" Edging Stand

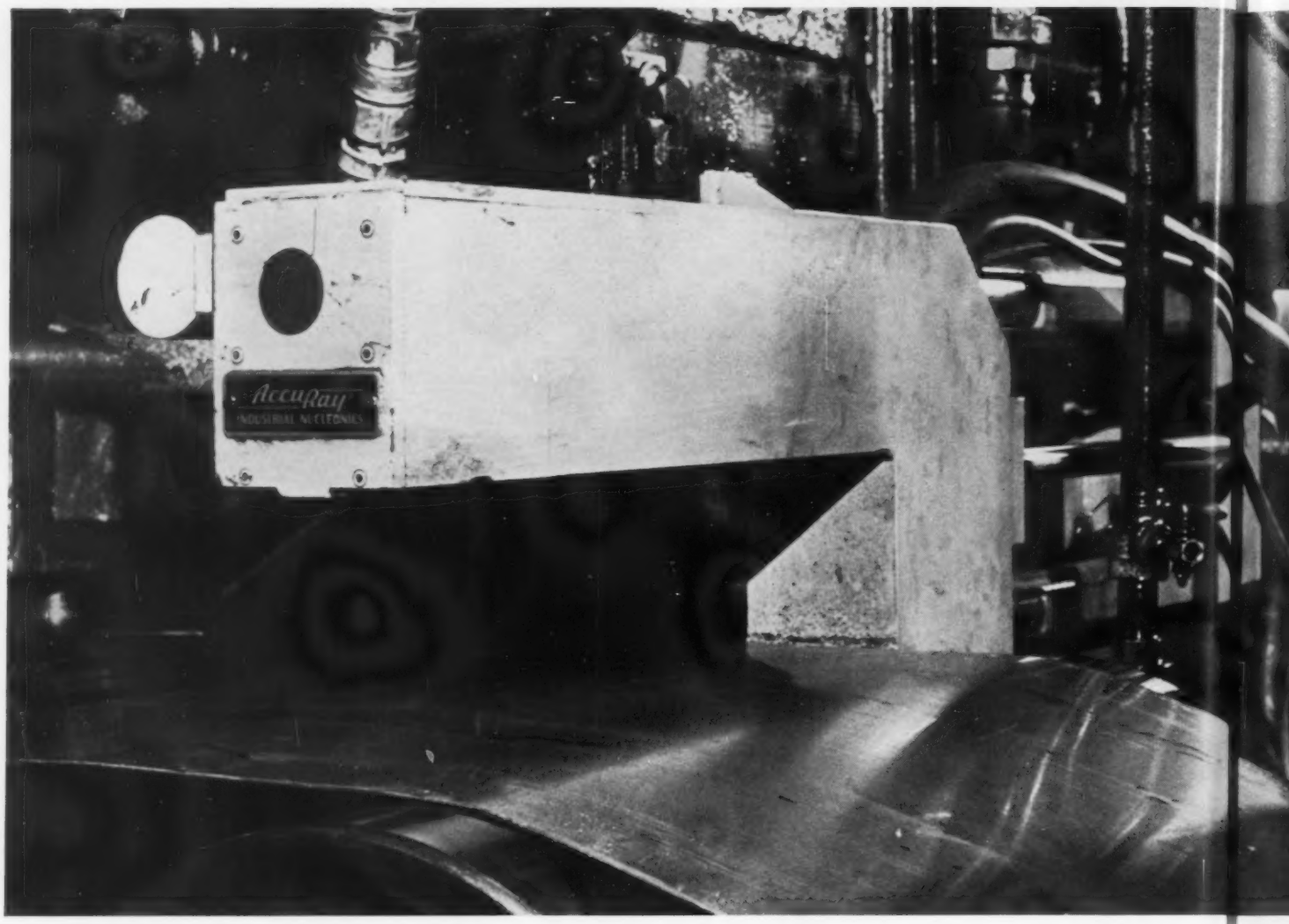
Rolling Strip Steel for Tin Plate in Coils on a MESTA 48" Four-High Five-Stand Tandem Cold Mill.



MESTA Hot Strip Mill Working Rolls

MESTA MACHINE COMPANY

PITTSBURGH, PENNSYLVANIA



AccuRay non-contacting ruggedized measuring units installed on each side of Reversing Mill at Acme Steel Company's Riverdale Works.

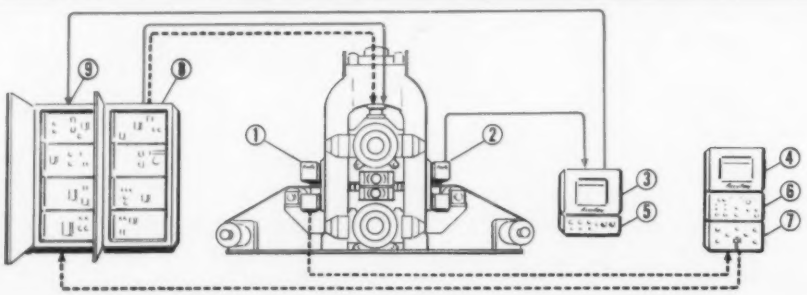
The task assigned to mill operating management at Acme Steel Company's Riverdale Works was not simple by any means . . . **"Reduce strip tolerance spread 50% with a minimum capital outlay for new equipment!"** The solution . . . install AccuRay Continuous Measurement and Control Systems on **all** cold rolled strip mills . . . Reversing, Sendzimer, and, the 4 and 5 stand tandem mills.

The inherent benefits of AccuRay Strip Thickness Control Systems demanded by Acme Steel . . . are close tolerance production, reduction of end scrap, increased productivity, and greater overall mill efficiency. The benefits to Acme's quality minded customers, manufacturers of appliances, office machines, automotive components, etc. . . . are prolonged tool and die life, fewer manufacturing rejects, and higher quality production.

As shown in the schematic below, the AccuRay Strip Thickness Measurement and Control System employes a number of elements to achieve continuous feedback control of a Reversing Mill at the Riverdale Works. Figures (1) and (2) show the non-contacting measuring units mounted on each side of the mill. Measurement accuracy is maintained at better than 1% through completely automatic standardization without use of shims or standard samples. Accuracy is also unaffected by surface conditions of the strip, strip "bounce", or strip speed.

All operating controls are packaged in modular form conveniently located at Operator's Control Station. Included in this group are; (3) and (4) Strip Chart Recorders presenting continuous thickness measurements reading directly in thousandths; (5) and (6) complete operating controls for AccuRay Measurement Systems; (7) Operating controls for AccuRay Auto-Controller which adjusts roll spacing through the screw-down motors.

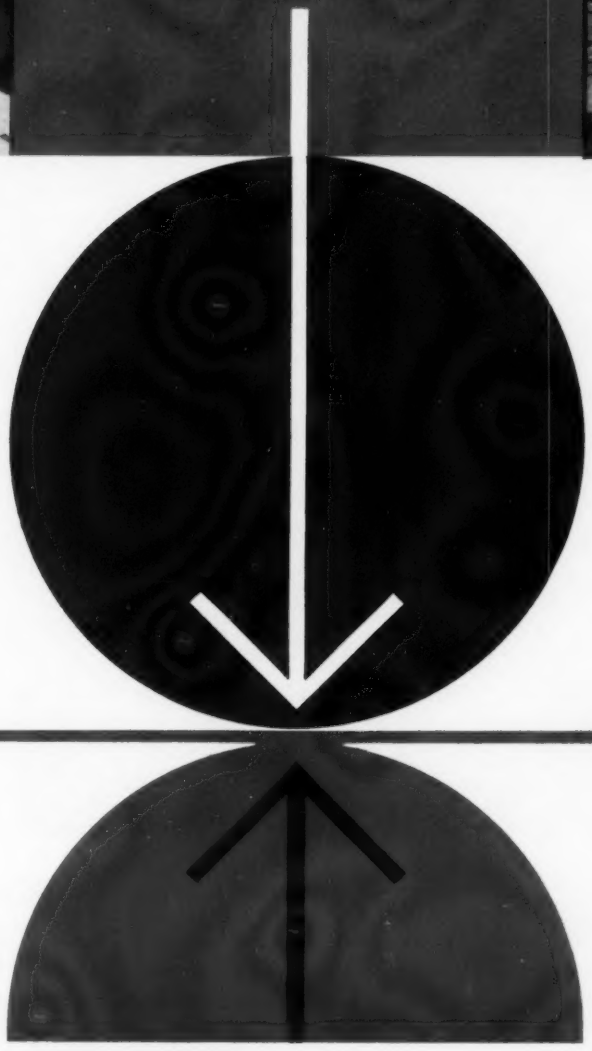
Figures (8), and (9) show the remoted Series "E" Bays. For ease in servicing, components are mounted in functionally pure modular units on swing-out doors.



ACME STEEL moves to REDUCE STRIP TOLERANCES 50% with AccuRay strip thickness control systems

Right Top—Gauging and Control circuits are contained in two floors mounted Series "E" Bays located in the motor room.

Right Below—Continuous thickness measurement is presented on strip chart recorders calibrated in absolute thickness units at the AccuRay Operators Control Station.



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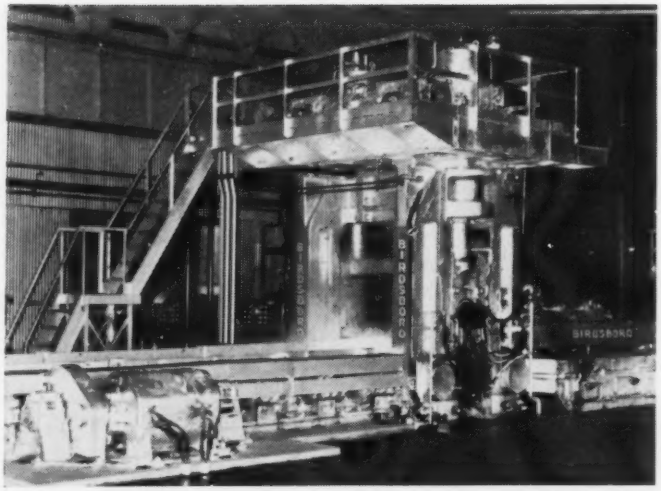
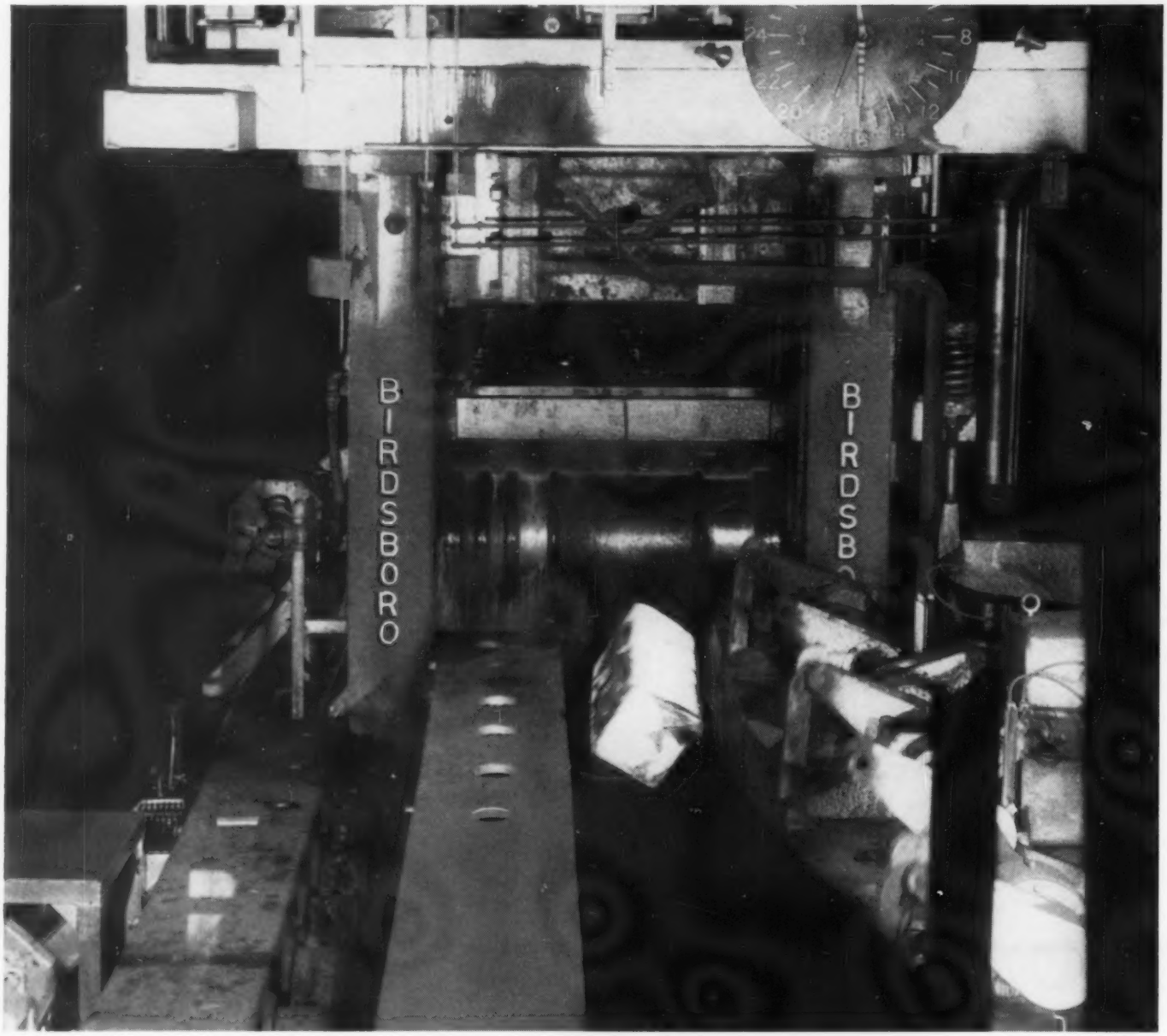
The WORLD'S LARGEST Manufacturer of Nucleonic Industrial Process Control Systems



Acme Steel Co. picks production partners carefully. Many other noteworthy companies have found that our imaginative, inventive and creative approach to steelmaking fits perfectly into their plans for present and future. As BIRDSBORO has assisted Acme on this installation, we can help you. *Sales Department, Engineering Department and Mfg. Plant:* Birdsboro, Pa., *District Office:* Pittsburgh, Pa.



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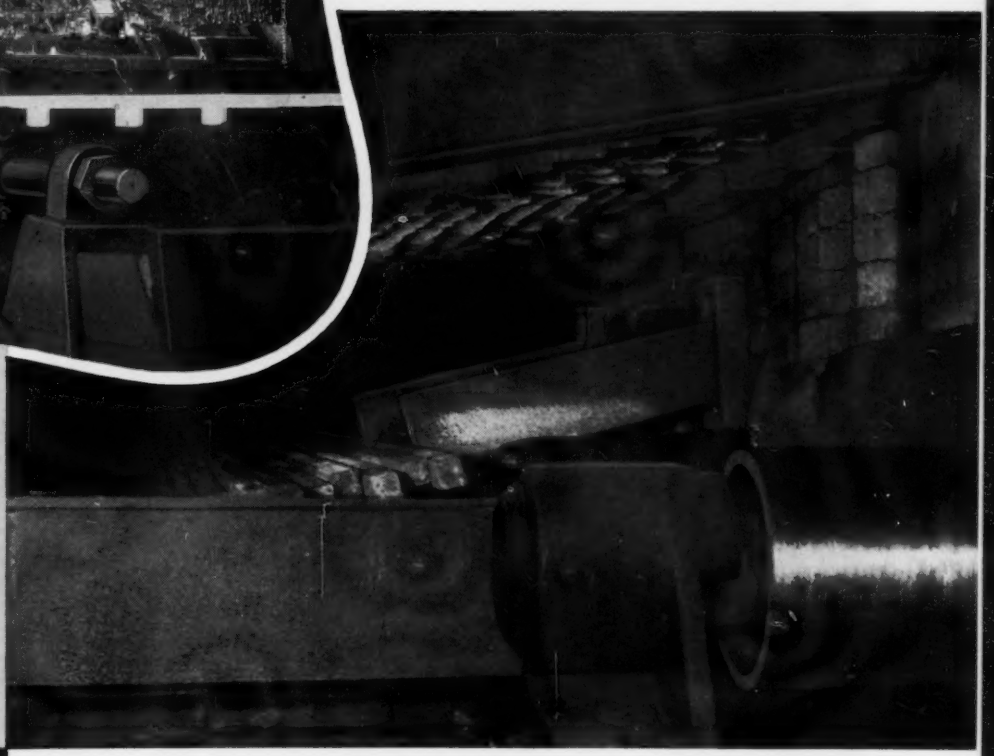
TRANTINYL SKIDS AND PUSHER ARMS

serve high tonnage requirements at

ACME STEEL COMPANY

Riverdale, Illinois



ABOVE: Discharge or drop off end of furnace with slab transfer table in Acme #2 Mill.

RIGHT: Acme #3 Mill furnace installation of Trantinyl Skids and Pusher Arms.

Trantinyl #6 Alloy Dry Skids used in Acme furnace hearth.

Long-lasting, trouble-free performance proves TRANTINYL dependability in Acme furnace skid applications . . .

In Acme #2 Mill Trantinyl #6 Alloy Skids are operating at furnace temperatures up to 2500° F. They are giving from *14 to 18 months'* service as compared to *5 to 8 weeks'* service given by old types of skids. In Acme #3 Mill furnace, installations of Trantinyl #6 Alloy Skids in service over 5 years are still in usable condition. Trantinyl Pusher Arms, shown above, have been in operation more than 1½ years and are also in good usable condition.

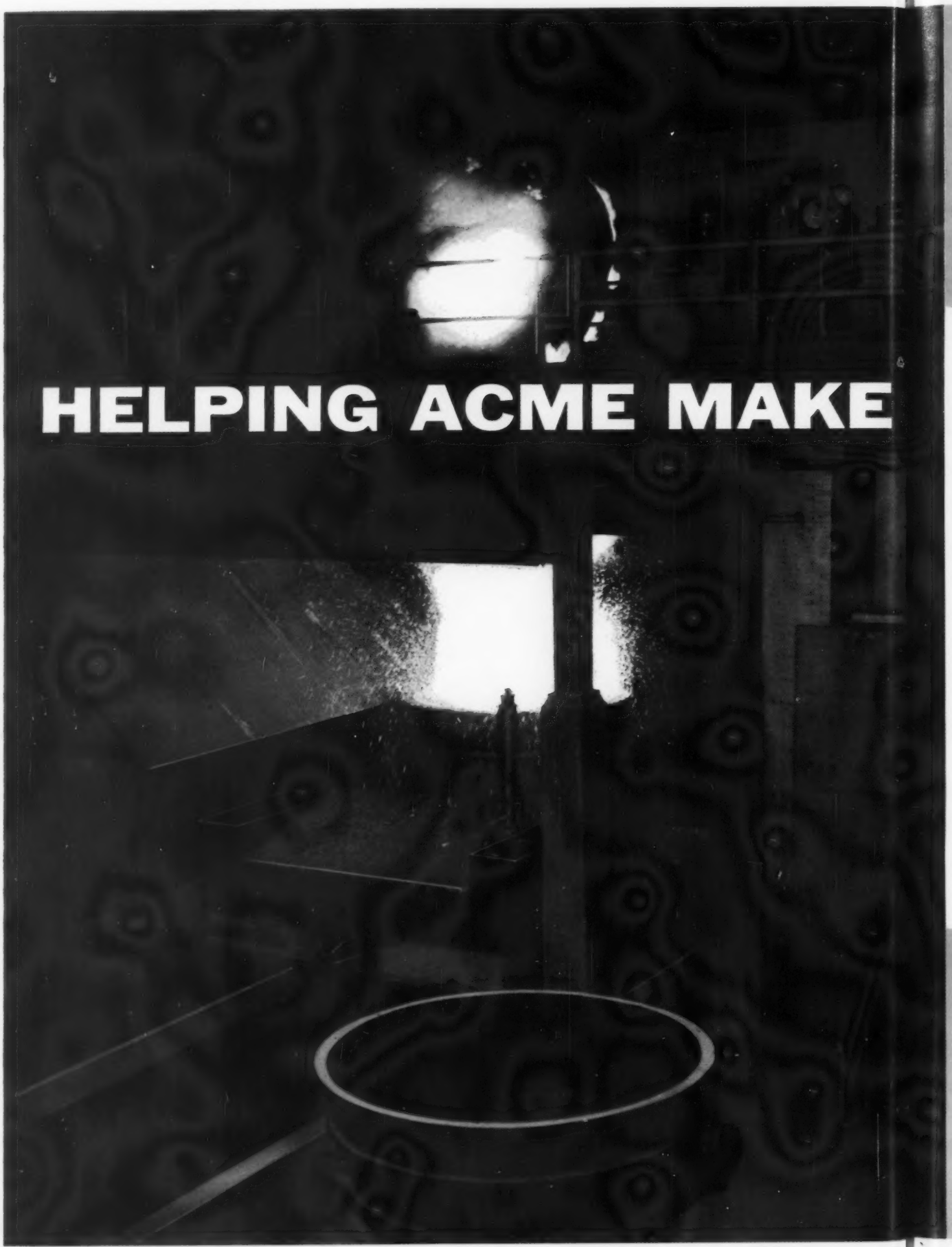
TRANTINYL GUIDES THE STEEL INDUSTRY

Youngstown Alloy Casting Corporation

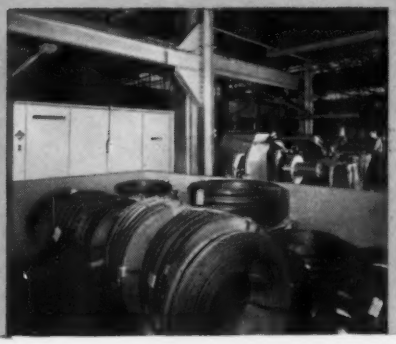
Youngstown, Ohio

G

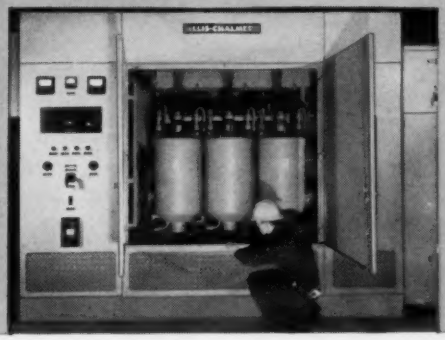
Sole Licensee to cast "TRANTINYL" for the Midwest, West and South: WAUNAKEE ALLOY CASTING CORP. Waunakee, Wis.


HELPING ACME MAKE

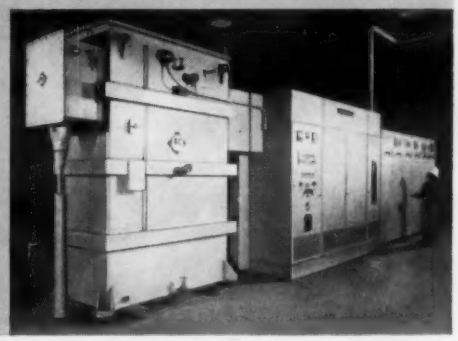
Package drive variable-speed unit provides precise speed regulation of slitter line. Rugged application requires dependable, heavy-duty equipment.



Metal-enclosed sealed-tube mercury arc rectifier and control compartment for a 1000-kw, 250-volt dc rectifier, located in the lower level of the melt shop.



Rectifier substation — complete with noninflammable liquid-immersed transformer, throat-connected to metal-enclosed rectifier tube and control compartment.



HISTORY IN STEEL

Allis-Chalmers supplies switchgear, rectifiers, motors, control, dc package drive, compressors for new plant built to produce 450,000 ingot tons a year—in 50-ton batches.

When Acme Steel Company, manufacturer of finished steel products, decided to produce its own steel it faced a king-size problem: how to produce a large annual volume, comprised almost entirely of small batches of a lot of different kinds of steel.

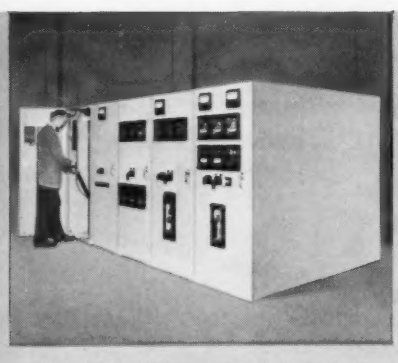
Acme solved the problem with a new $35-million Chicago plant and a combination of continuous-flow, hot-blast cupolas and basic oxygen furnaces. Resulting efficiency and flexibility of plant, raw material and finished product are unique in the steelmaking industry.

Allis-Chalmers has played an important part in this project. From the beginning, A-C engineers helped to develop the system that is working successfully today. And A-C equipment, throughout the plant, is meeting the daily demand for flexible operation.

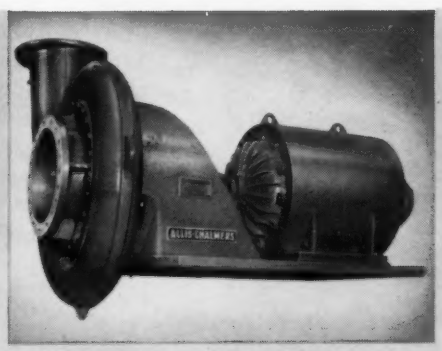
What are *your* plans for plant expansion or modernization? Allis-Chalmers has the depth of experience and the range of products to help you set the pace in a growing industrial world. *Contact your A-C representative for details, or write* ***Allis-Chalmers,*** *Power Equipment Division, Milwaukee 1, Wisconsin.*

ALLIS-CHALMERS

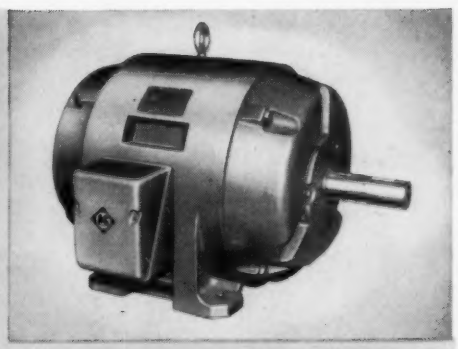
A-1265



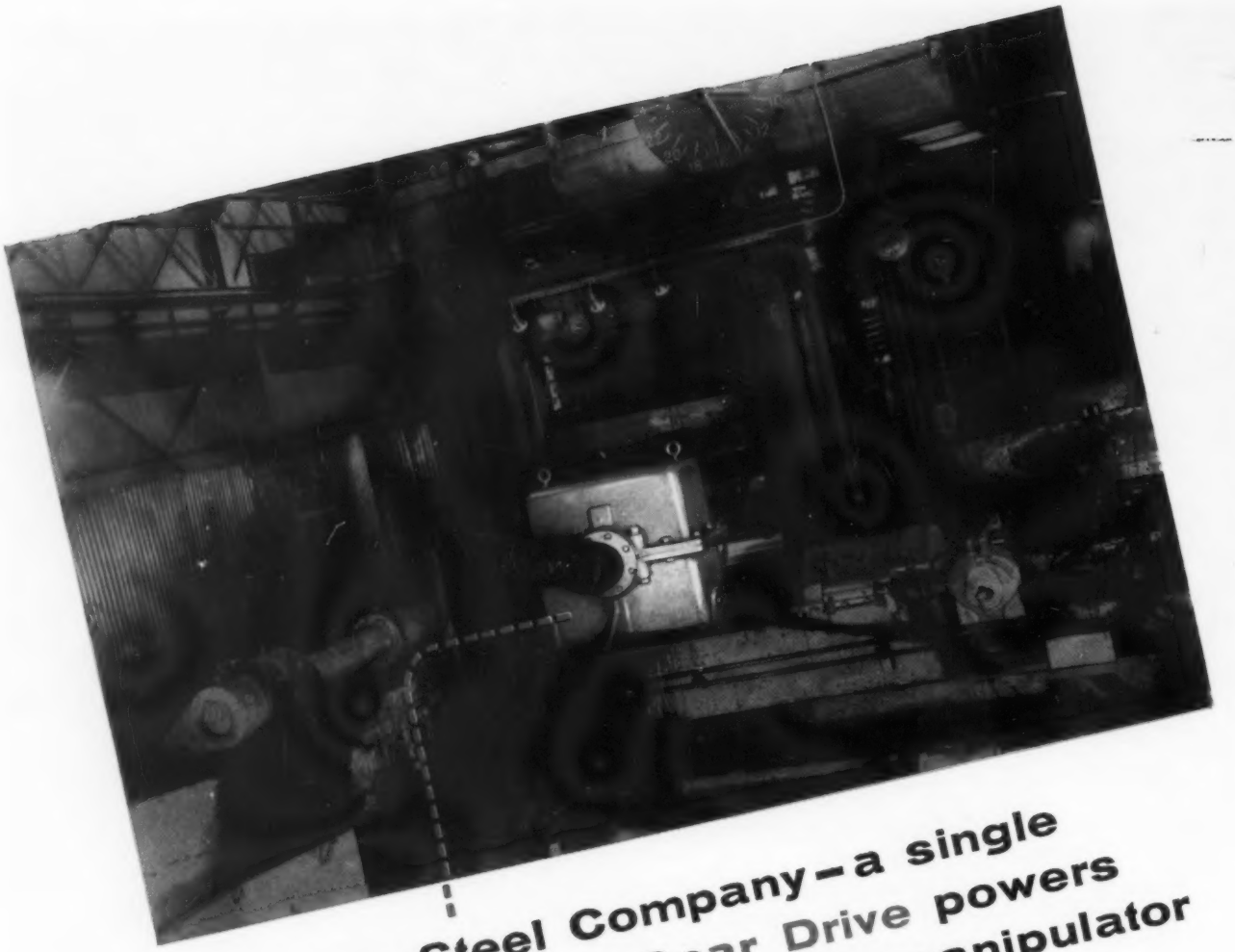
Typical 5-kv, 350-mva metal-clad switchgear for synchronous motors of m-g sets along with 15-kv, 750-mva switchgear for primary distribution in new addition.



Two Allis-Chalmers motor-driven 1161-cfm compressors, typical of the one shown here, deliver butane gas to a process furnace at Acme Steel Company.



Three 125-hp Allis-Chalmers motors operate on a full 24-hour schedule, driving blowers which supply hot air to soaking pits in blooming mill area.



At Acme Steel Company—a single Cleveland Worm Gear Drive powers this rugged blooming mill manipulator

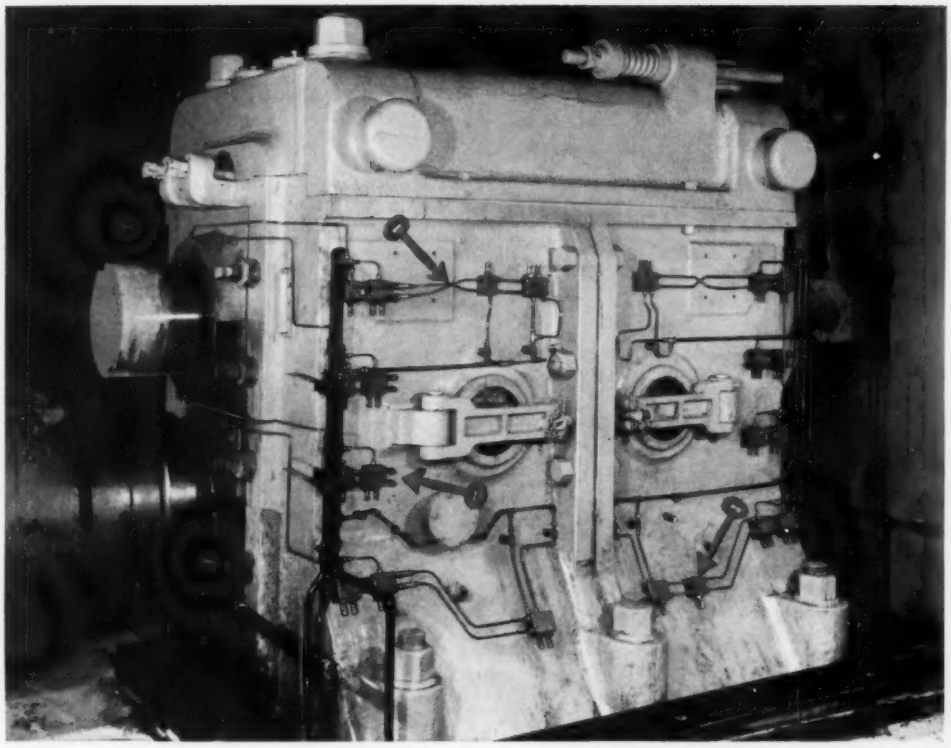
Here's a single, rugged Cleveland Worm Gear Drive that supplies dependable trouble-free power transmission for peak performance of the manipulator on Acme Steel Company's new blooming mill at Riverdale, Illinois.

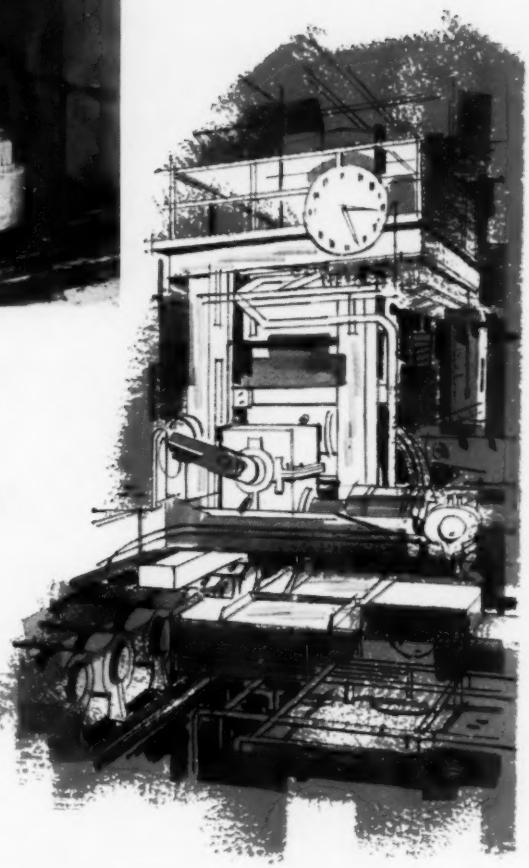
A total of over 200 Clevelands daily work 'round-the-clock transmitting power to various important equipment installations at Acme Steel Company.

Throughout industry, Cleveland Worm Gear Drives and Speed Reducers are used on all kinds of tough jobs, wherever dependable power transmission is vital. Compact and space-saving, Clevelands have high shock load resistance. Their case-hardened steel worms and long wearing nickel-bronze gears actually improve with use. Even operating under continued, severe overloads, danger of sudden failure is remote.

Write today for new Bulletin 145 showing the wide size range of Speed Reducers in the Cleveland line—or better yet, contact your nearest Cleveland Representative.

Cleveland Worm & Gear Division
Eaton Manufacturing Company
3278 East 80th Street • Cleveland 4, Ohio





Farval lubrication helps keep Acme Steel's blooming mill on 'round-the-clock operation

Here's the delivery end of a recently installed Farval air-operated time clock-controlled spray system. It provides dependable 'round-the-clock lubrication at 18 points for the internal gearing in this new blooming mill pinion stand at Acme Steel Company, Riverdale, Illinois. An engineered overflow arrangement returns the lubricant back to an air-operated barrel pump attached to a 400-pound drum.

Throughout Acme Steel's expansion program, eleven Farval systems are busy at work lubricating vital bearings on all types of production equipment . . . Steel plant engineers know from experience that Farval Dualine Lubrication Systems

- Increase Bearing Life
- Save Both Labor and Lubricant
- Enhance Good Housekeeping
- Keep Machines Operating Continuously
- Eliminate Hazardous Hand Lubrication

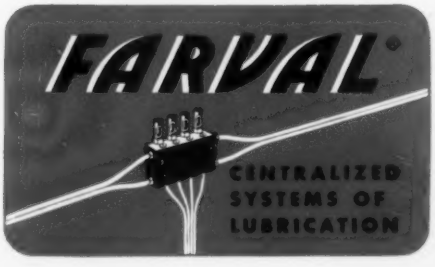
No wonder virtually every major steel producer chooses Farval for their heavy-duty lubrication requirements.

Get the complete cost-cutting story from your Farval representative—or write today for free revised Bulletin 26-T.

KEYS TO ADEQUATE LUBRICATION
—wherever you see the sign of Farval—familiar valve manifolds, dual lubricant lines and pump stations—you know rolling mill equipment is being properly lubricated.

Farval Studies in Centralized Lubrication No. 250

Farval Division • Eaton Manufacturing Company
3278 East 80th Street • Cleveland 4, Ohio



Acme Steel chose Westinghouse: the only self-adjusting

D-C magnetic brake

Simplicity of construction— minimum number of parts means years of trouble-free operation

Now, brake adjustment problems are gone forever. With Westinghouse exclusive self-adjusting d-c magnetic brakes, the need for adjustment is eliminated—for the life of the brake lining.

Regardless of lining wear—or wheel expansion—the SA brake shoe is always in correct adjustment and proper alignment.

Field tests show self-alignment of SA brakes permits even lining wear—shoe tips cannot drag. Lining life is increased up to 50%. Wheel wear and scoring are minimized for longer wheel life.

For complete information on industry's most advanced d-c magnetic brake, call your WESTINGHOUSE sales engineer. Or, write Westinghouse Electric Corporation, 3 Gateway Center, P.O. Box 868, Pittsburgh 30, Pennsylvania. Ask for B-6547.

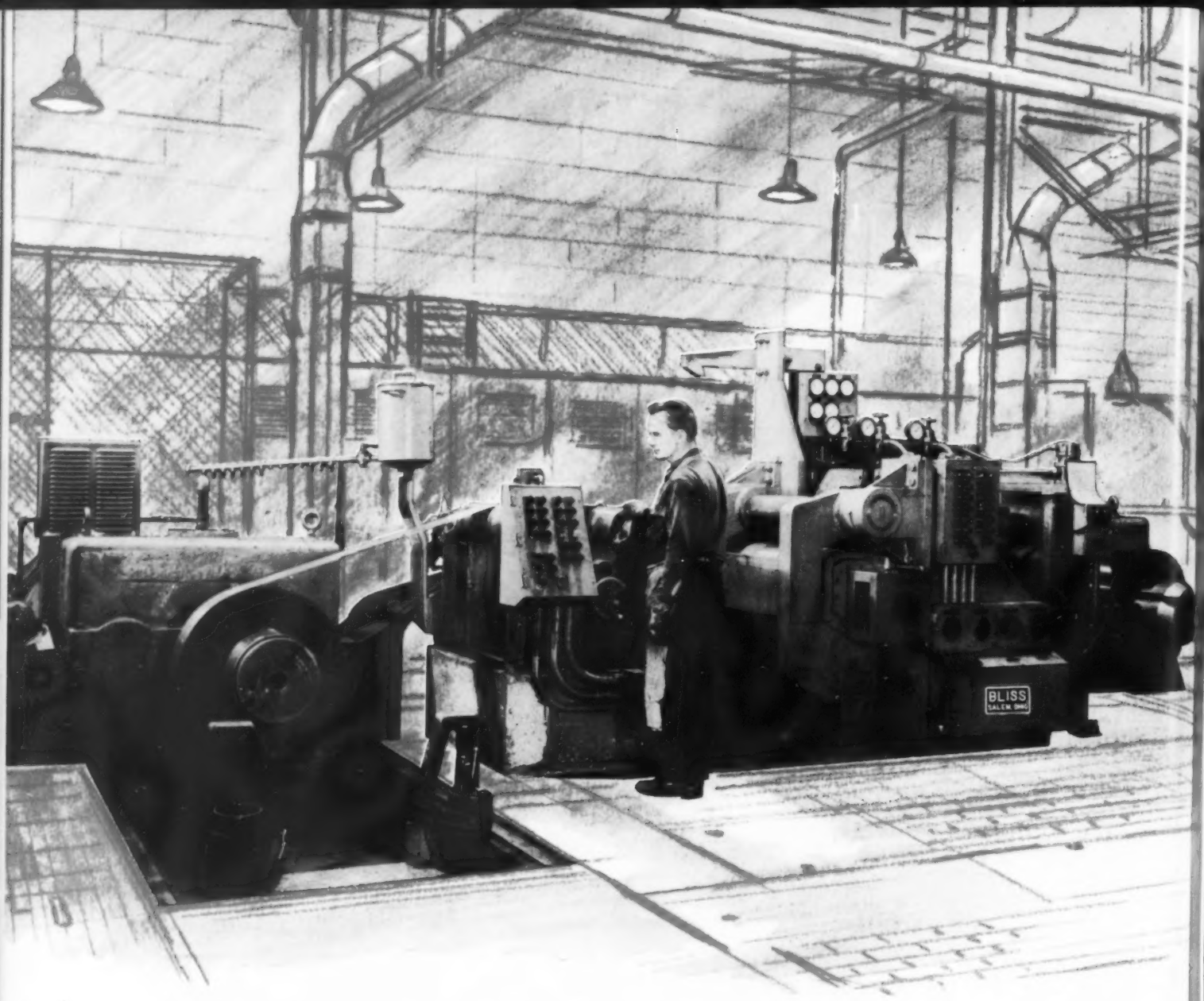
J-22048-R

YOU CAN BE SURE...IF IT'S Westinghouse

WATCH "WESTINGHOUSE LUCILLE BALL-DESI ARNAZ SHOWS" CBS TV ALTERNATE FRIDAYS

Westinghouse mill motors with silicone insulation

are giving top performance on the toughest applications. Silicone insulation plus greater capacity and cooler operation of improved field coil design . . . heavy-duty shaft, bearing and housing design to take high torque loads . . . give you longer, more dependable motor life with Westinghouse Hevi-duty Mill Motors. For all the details, ask for B-6547.



How Bliss helps ease the tension at Acme Steel

This new rewind line, designed and built by Bliss' Rolling Mill Division, helps Acme Steel's Riverdale, Ill., plant achieve a higher quality cold rolled strip.

All strip in widths from 2" to 26" and gages of .050" and thinner is run through the line before annealing. Between the line's mandrel-type payoff reel and the tension reel are a pinch roll and an electrically-controlled bridle which the operator sets for various strip widths and gages.

The tension applied between the bridle and the tension reel "relaxes" the strip so that it won't stick when it goes through the annealing furnace. Maximum speed through the rewind line is 1000 feet per minute and it is in operation almost continuously.

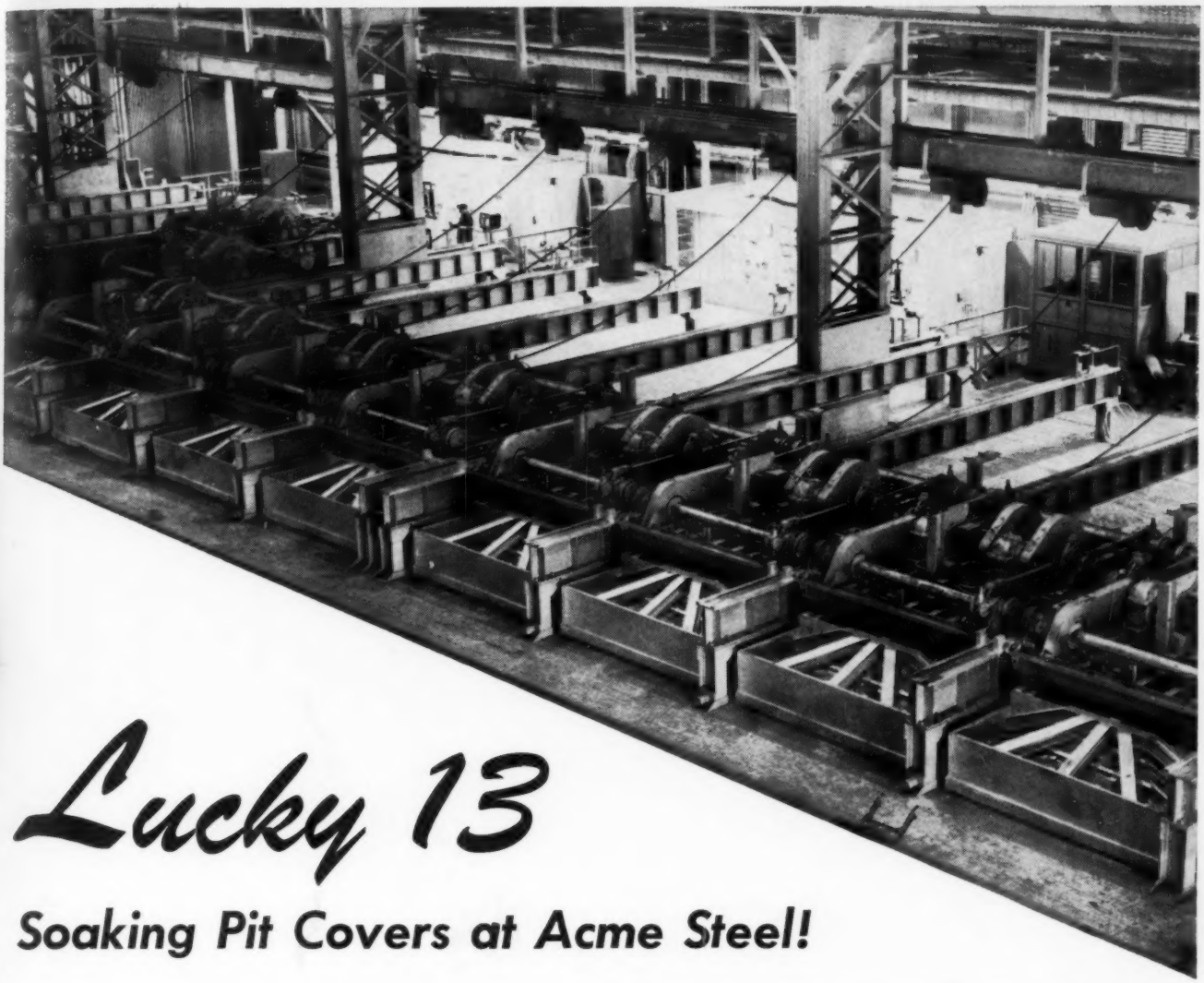
It's another illustration of how Bliss engineering can solve a metal rolling plant's problems. For other examples of Bliss Rolling Mill installations, write today for your copy of the 84-page Bliss Rolling Mill Brochure, Bulletin 40-B.

BLISS
SINCE 1857

Bliss is more than a name . . . it's a guarantee

E. W. BLISS COMPANY, Rolling Mill Division, Salem, Ohio

Subsidiary: The Matteson Equipment Company, Inc., Poland, Ohio



Lucky 13

Soaking Pit Covers at Acme Steel!

"The best sign of satisfaction is a repeat order — which is the best endorsement."

Ramtite is our business . . . Not a side line!

The Acme Steel Company Plant at Riverdale, Illinois, selected RAMTITE No. 25 for *thirteen* soaking pit covers.

For a number of years, this mill has used RAMTITE in reheat furnaces. So their experience guided them to use what could be expected to give the utmost satisfaction—SPECIAL SUPER RAMTITE® No. 25.

RAMTITE No. 25 with its versatility might readily solve some of your refractory problems. Our Sales Engineer in your locality or area can be helpful, if you ask him to call. Or learn more about Ramtite 25 by sending the coupon below. *Remember, Ramtite sees a job through from start to finish—design, construction, installation, working closely with your own engineers, staff and crew.*

The Ramtite Co.
DIV. OF THE S. OBERMAYER CO.
1813 S. Rockwell St., Chicago 8, Ill.

THE RAMTITE CO., Div. of The S. Obermayer Co.
1813 S. Rockwell St., Chicago 8, Ill.

☐ We are interested in Ramtite. Please furnish information.
☐ Send folder about your new Ramtite — "90-RAM"

Company Name_____

Attn. Mr._____ Title_____

Address_____

City_____ Zone____ State_____

all over ACME STEEL

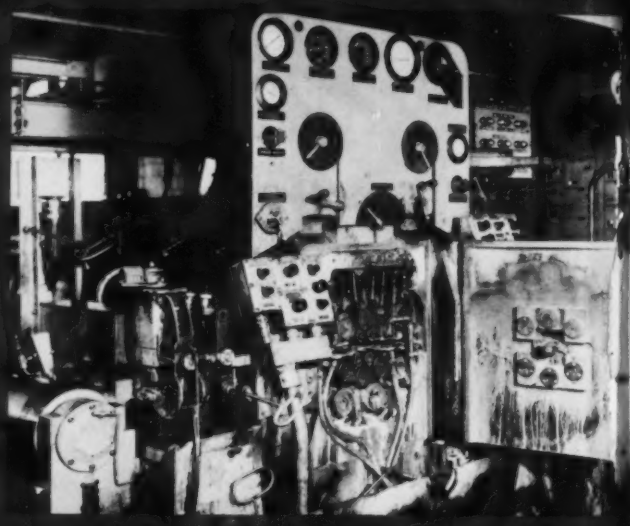
TSP

"TOOL STEEL PROCESS" hardened products are widely used at Acme Steel Co. They include screw down screws and nuts, gears and pinions for all services; track and sheave wheels; leveller, pinch, back-up and coiler carrying rolls; cold rolling rolls, arbors, shafts and axles, sprockets, and mill pinions. A few of the many TSP parts in use at Acme Steel are illustrated here.

All TSP products are hardened by our special process. The file hard surface to full depth of permissible wear gives maximum life. The core, refined for toughness and ductility gives maximum strength.

TSP

TSP



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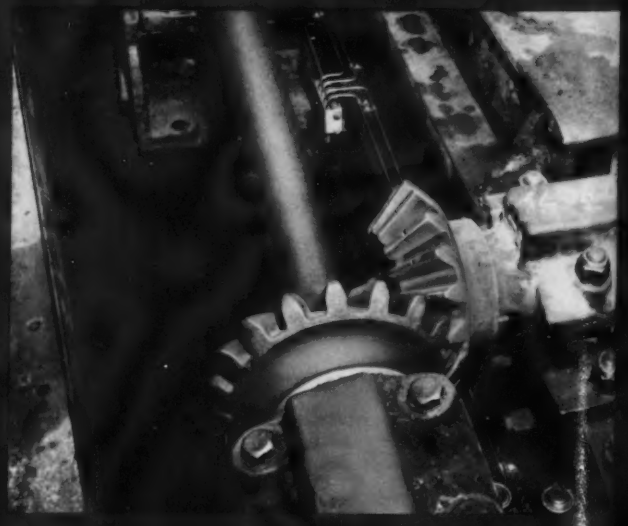

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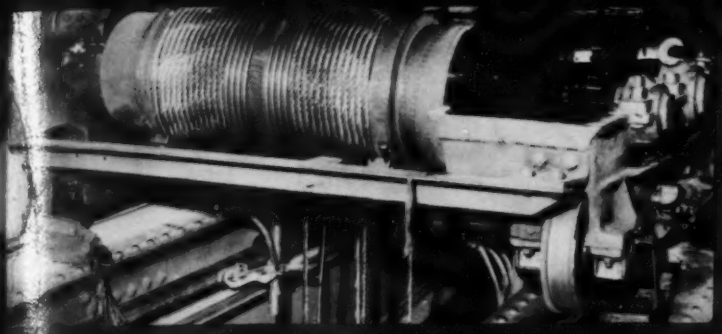

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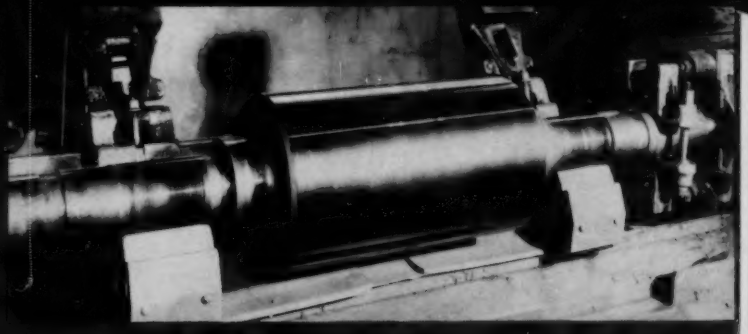

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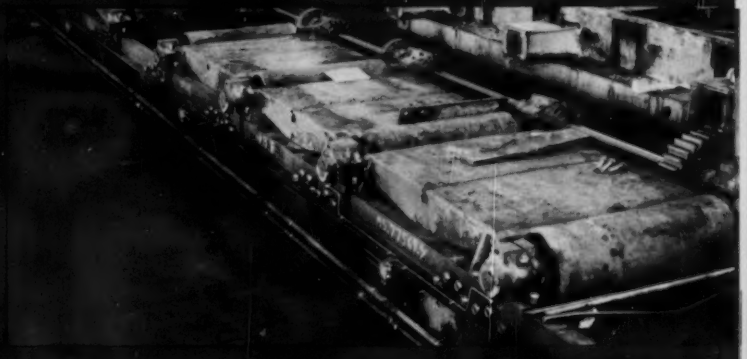

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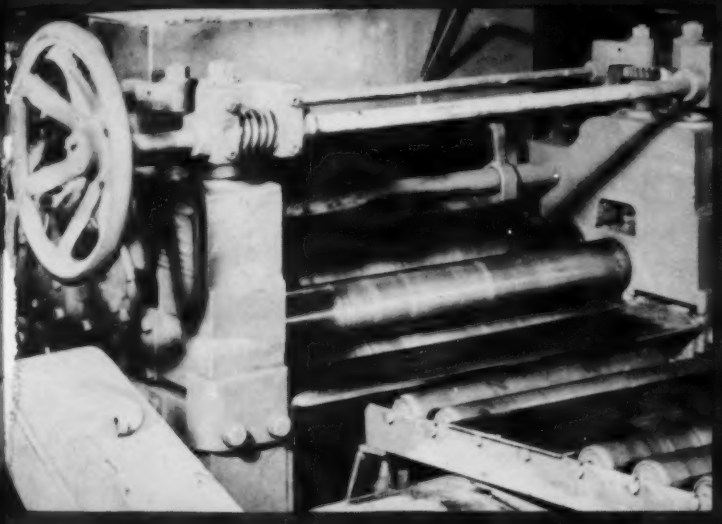

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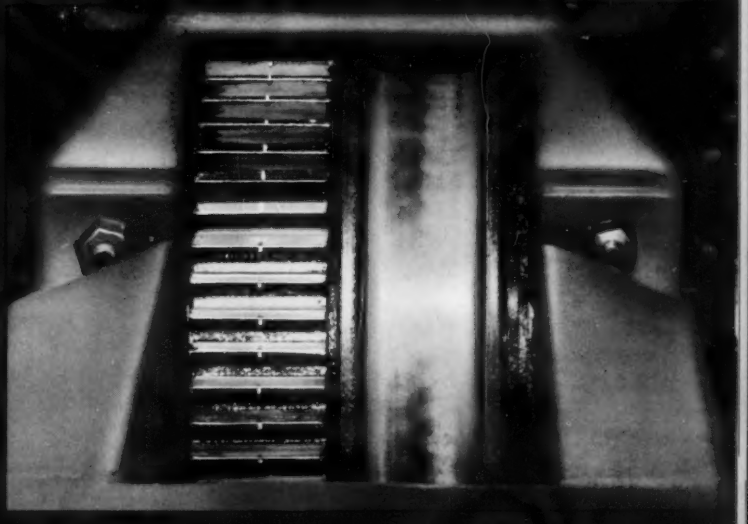


TSP

You receive a written guarantee that TSP products will give you a longer life in the same service than any other product—That's why they reduce maintenance and replacement costs Write today—comprehensive literature tells you how TSP products can save money for you

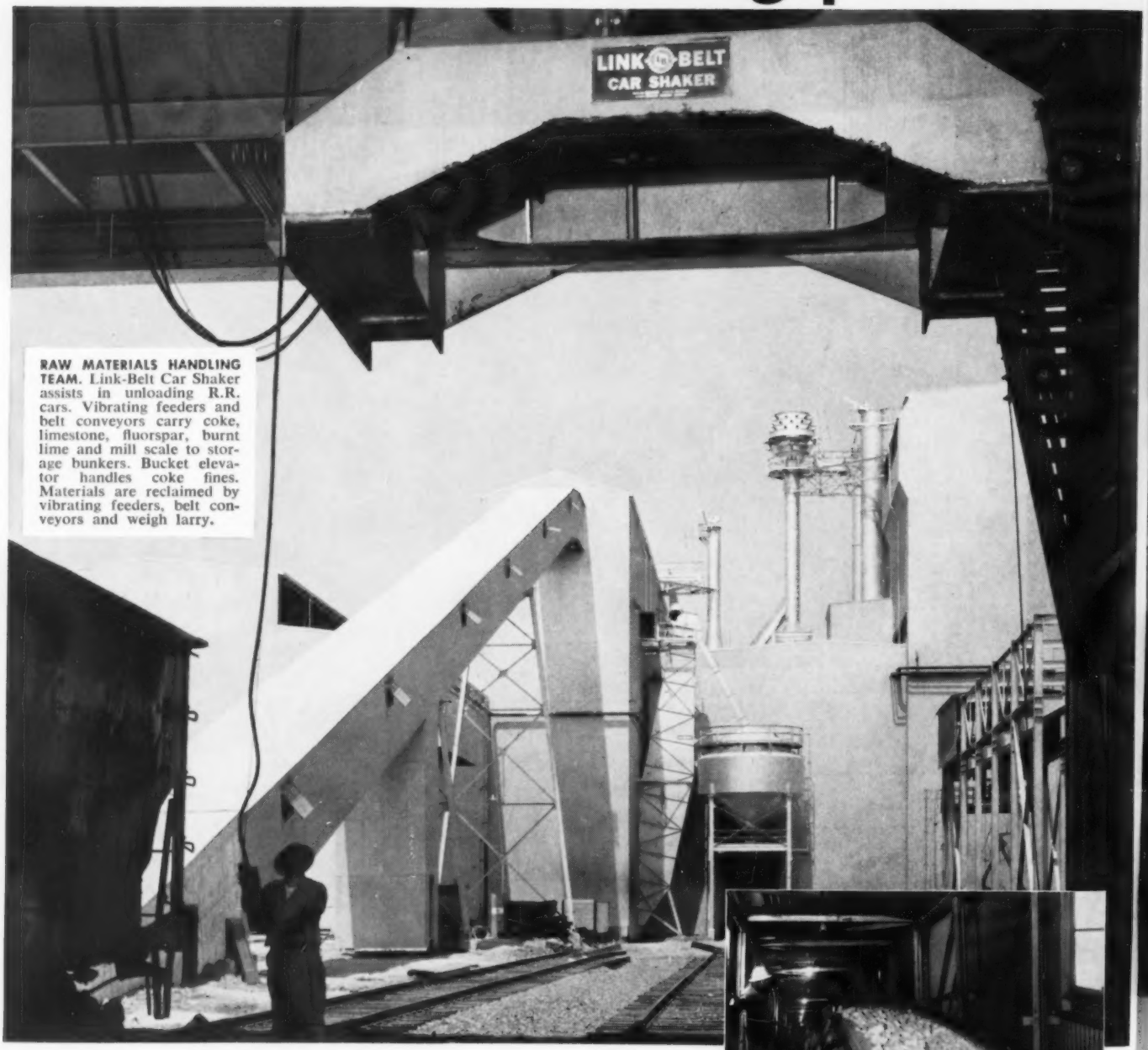
THE TOOL STEEL GEAR AND PINION CO.

CINCINNATI 36, OHIO, U. S. A.

MEMBER OF AGMA

How LINK-BELT equipment helps

coordinate steel-making processes



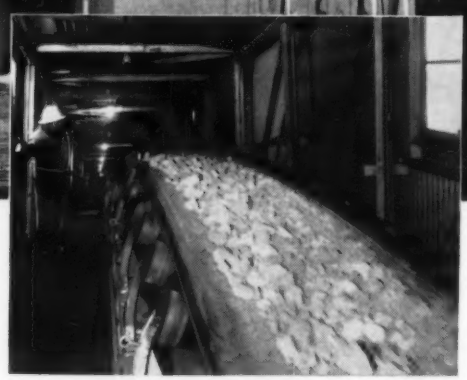
RAW MATERIALS HANDLING TEAM. Link-Belt Car Shaker assists in unloading R.R. cars. Vibrating feeders and belt conveyors carry coke, limestone, fluorspar, burnt lime and mill scale to storage bunkers. Bucket elevator handles coke fines. Materials are reclaimed by vibrating feeders, belt conveyors and weigh larry.

Smooth handling through many steps cuts costs for Acme Steel

Efficient steel-making demands efficient handling of raw materials from railroad cars, into and out of storage, to charging equipment feeding cupolas and oxygen converters. At Acme Steel, Riverdale, Ill. plant, Link-Belt car shaker, belt conveyors, vibrating feeders, bucket elevator and weigh larry keep materials flowing smoothly from one step to another.

Steel mills throughout the country are benefiting from straight-through handling with Link-Belt equipment. Methods that have eliminated waste, cut corners in bulk handling and improved overall plant efficiency.

For complete details on single machines or complete systems, contact your nearest Link-Belt office. Ask for Book 2764.



INCLINED BELT CONVEYOR carries raw materials to height of 104 ft. at a speed of 250 fpm.

LINK-BELT

MATERIALS HANDLING, PROCESSING
AND POWER TRANSMISSION MACHINERY

LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1. To Serve Industry There Are Link-Belt Plants, Warehouses and District Sales Offices in All Principal Cities. Export Office, New York 7; Australia, Marrickville (Sydney); Brazil, Sao Paulo; Canada, Scarboro (Toronto 13); South Africa, Springs. Representatives Throughout the World.

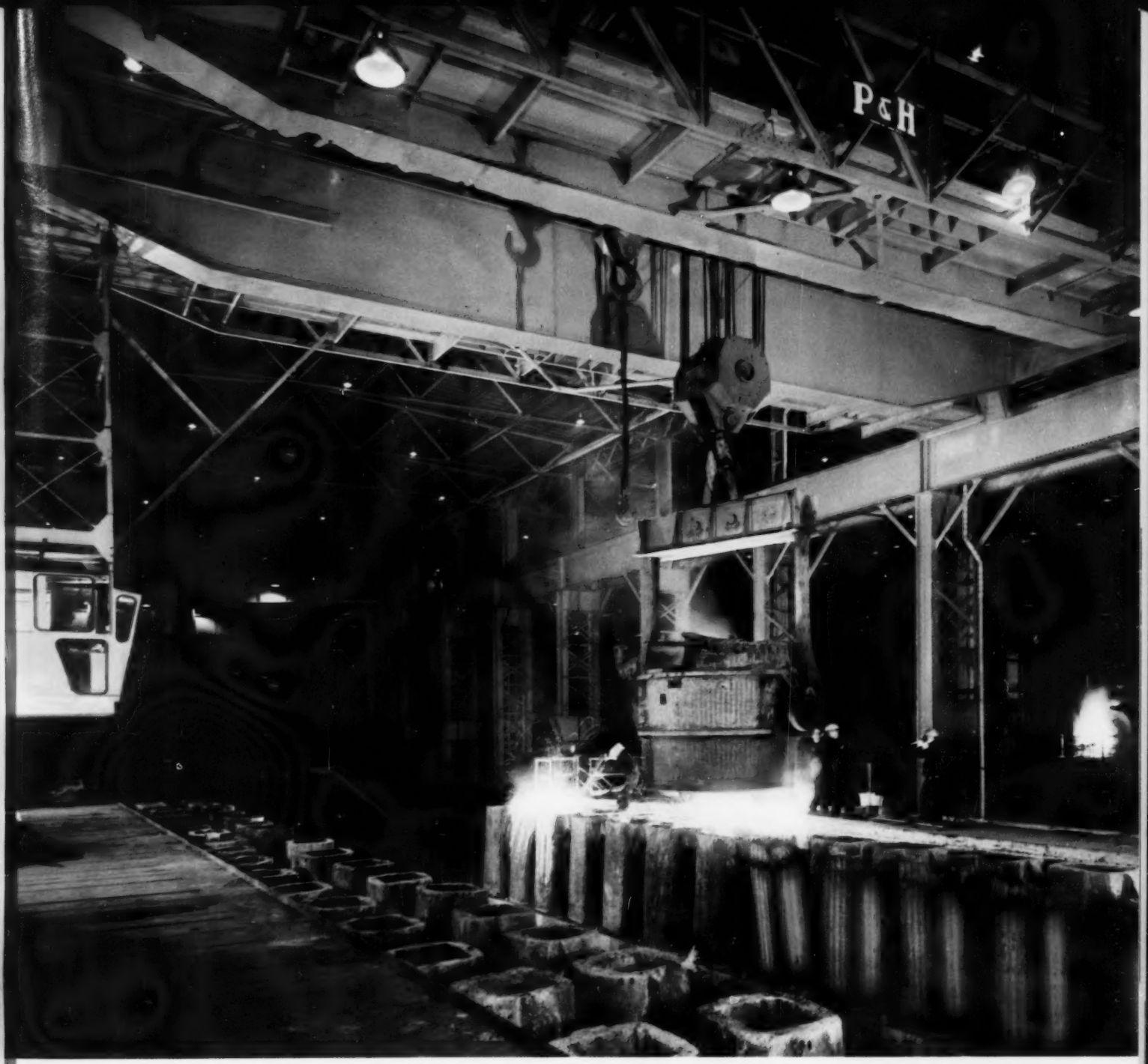


Photo courtesy Acme Steel Company, Riverdale, Illinois.

FOR EVERY APPLICATION, THERE'S ONE CRANE OUTSTANDING...

IN STEEL MILLS: This 100-ton P&H crane lifts, transports and "spots" tremendous loads of molten steel as surely and deftly as you handle a coffee cup.

P&H steel mill cranes perform tasks like this effortlessly and dependably because they are specifically designed for steel mill service . . . to handle massive loads, withstand searing heat, ignore frequent shock loads.

What's more, P&H carefully engineers every crane to meet specific job requirements . . . to consider all factors affecting performance. Special operating problems are taken in stride. Result: P&H cranes chalk up almost unbelievable service records month after month, year after year, decade after decade.

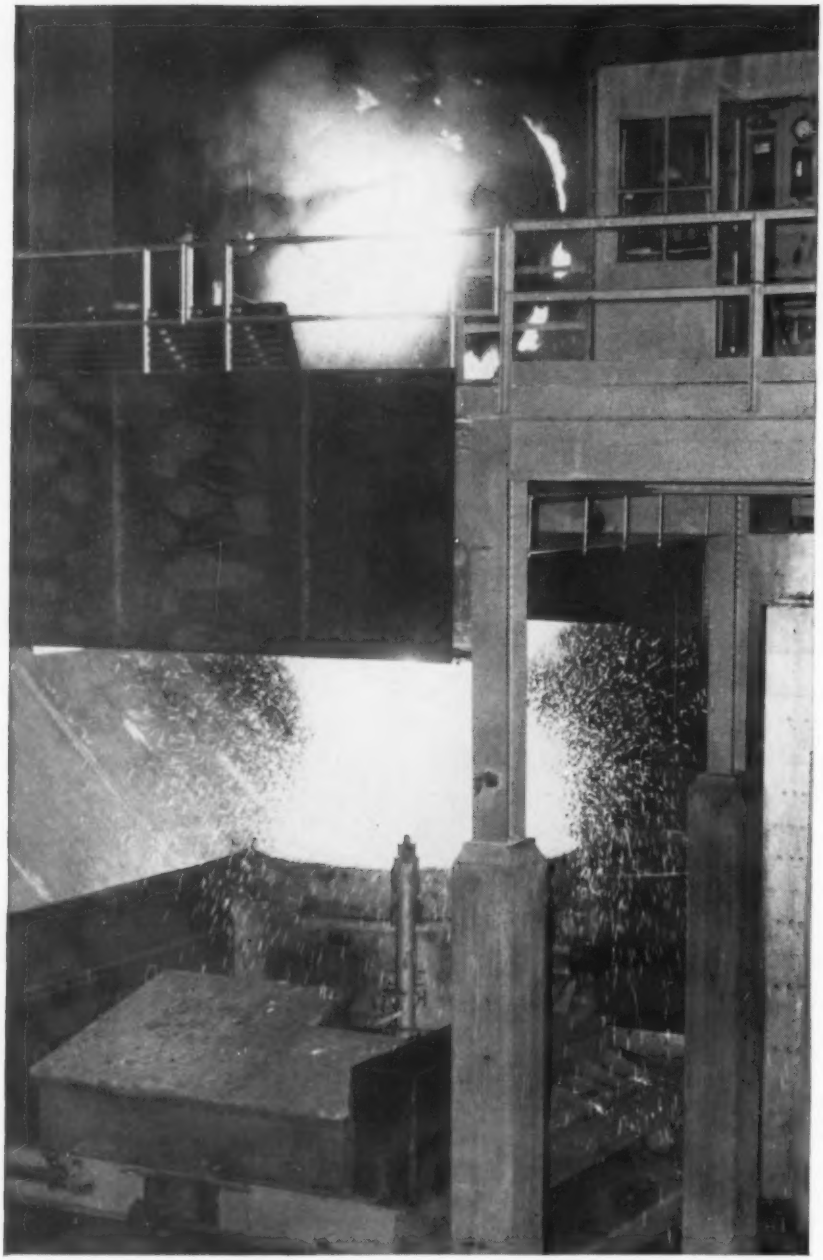
Isn't this the kind of performance you want, too? Write for bulletin C-42 to Dept. 120, Harnischfeger Corporation, Milwaukee 46, Wis.

P&H enclosed cabs have full-view safety glass windows, for unrestricted view of work area. Cabs can be heated and air conditioned where cold, heat, smoke or fumes render ordinary cabs uncomfortable or unsafe.

P&H
OVERHEAD CRANES

HARNISCHFEGER
Milwaukee 46, Wisconsin

YOU GET A BONUS OF EXTRA SERVICE IN THESE PERFORMANCE-PROVED REFRACTORIES BY WALSH!



Exacting demands are made on Walsh Refractories installed in steel ladles at Acme Steel Company, Riverdale, Illinois.

WALSH METALOK HEATSETTING MORTAR

Successfully coping with the progressively higher temperatures and more severe service conditions imposed in today's steel melting operations, Metalok retards joint penetration in steel ladles and offers unusual resistance to heavily laden iron oxide slags. Result: cleaner metal . . . longer service life . . . greater value per dollar invested.

WALSH MORT-AIRSET

Airsetting High Temperature Bonding Mortar

The ideal stopper rod cement because of its higher moisture retention and smoother working qualities. *Absolutely does not ball or gum up in the drum but is always in useable condition.* Noted for its stronger, tighter bond—desirable qualities that result in longer service life, not only on stopper rods, but wherever stronger gas-tight joints are required.

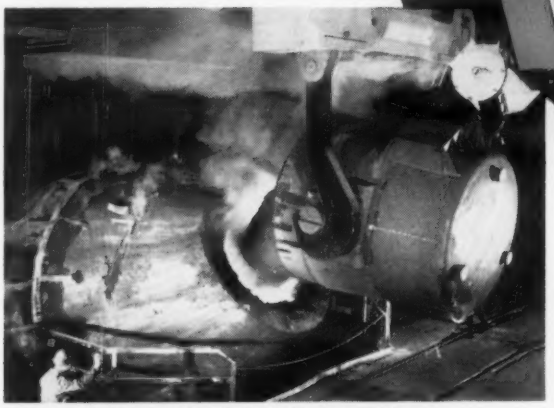
Walsh Ladle Brick installed and maintained with Walsh Metalok Mortar excel in resistance to increasingly higher temperature requirements of open hearth and oxygen converter heats at tap time as well as the greater mechanical and temperature shock brought about by the sudden velocity of metal pouring.

WALSH REFRACTORIES CORPORATION — America's Best Clays

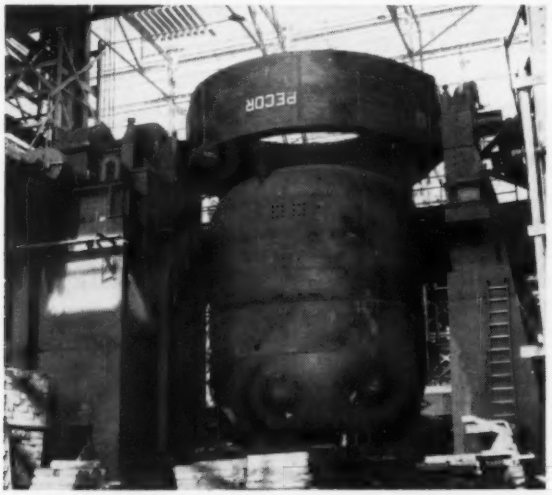
WALSH REFRACTORIES CORPORATION

101 FERRY STREET • ST. LOUIS 7, MISSOURI

SPECIALISTS IN REFRACTORIES OF HIGH BULK DENSITY AND LOW POROSITY



Jones & Laughlin Steel Corporation
Aliquippa Works



Kaiser Steel Corporation
Fontana Works

. . . MORE COMING!

In fact, PECor has fabricated all of the Basic Oxygen Furnaces that are in use or now being installed in America, including the major portion of the auxiliary equipment. When you have need of heavy machinery or equipment, rely on PECor's 75 years' experience in designing and fabricating for the steel, chemical, oil and other industries.

PENNSYLVANIA ENGINEERING CORPORATION
NEW CASTLE, PA.

OTHER STEEL PLANT EQUIPMENT WE BUILD

Blast Furnaces • Scrap Cars • Slag Cars
Oxygen Converters • Bessemer Converters
Hot Metal Mixers • Ore Transfer Cars
Ladles • Jack Cars • Ladle Transfer Cars
Ingot Cars • Mixer Cars • Thermo Metal (Bottle) Cars • Scale Cars

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Sales Representatives
Wooldridge Co., Burlingame, Cal.
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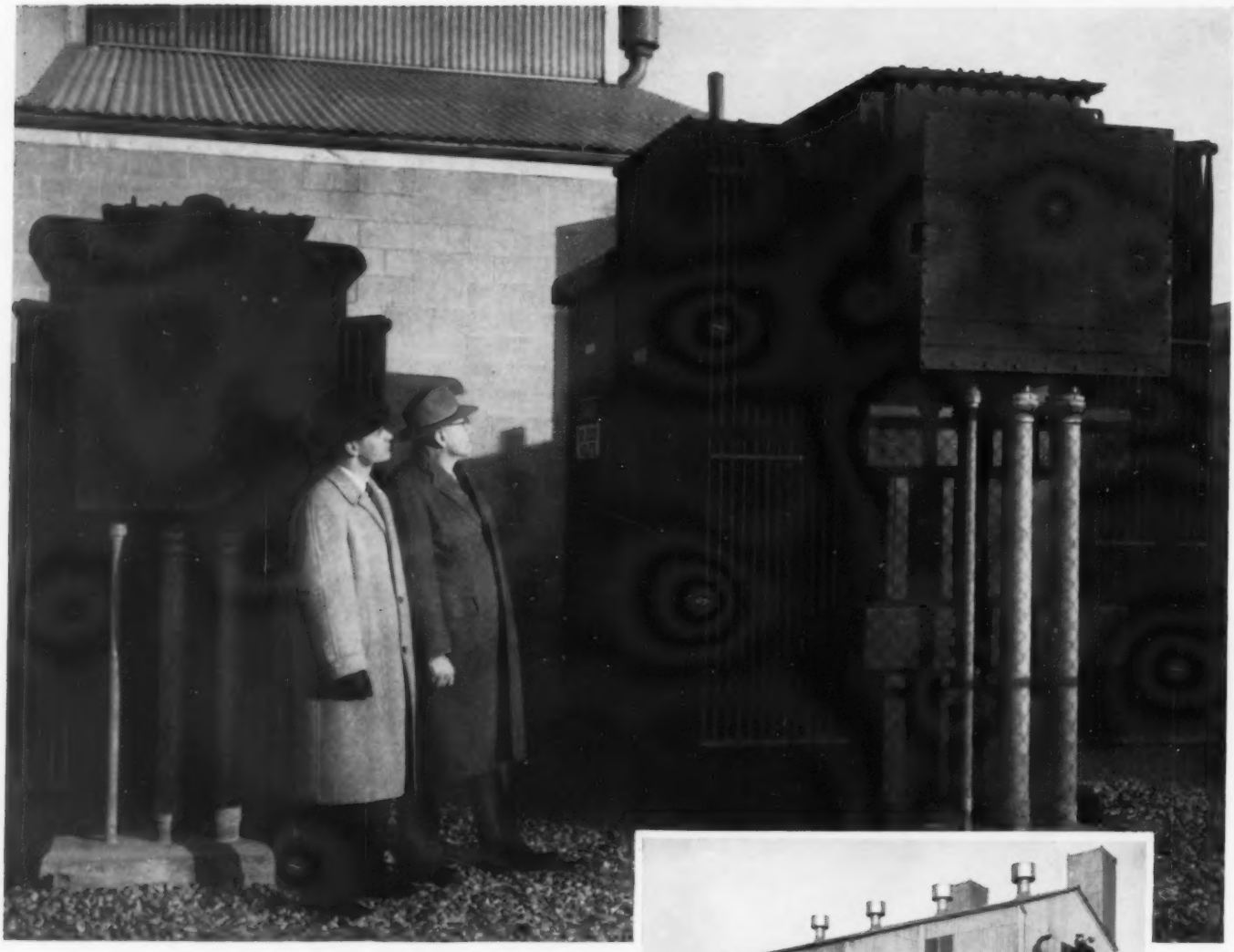


These Wagner Transformers . . .

HELP MAKE OXYGEN FOR ACME STEEL'S RIVERDALE PLANT

The Cupola-Converter Process used by Acme Steel at its Riverdale facility is an innovation in steel-making. The process has a hearty appetite for oxygen . . . about 2,000 cubic feet of pure oxygen for every ingot ton of steel produced. With an annual capacity in excess of 450,000 ingot tons, that means a lot of oxygen must be produced.

The oxygen generating plant at Riverdale is powered by the two Wagner Substation Transformers shown here. Both do their job well . . . work without pause to provide all the power the plant needs. One is rated 5,000 kva, the other 1,000 kva. Both have Wagner-built high voltage fused interrupter switches.

Now, what about your transformer requirements? You may not, of course, need to power-up to produce some 95 billion cubic feet of oxygen annually; but, you do need power. More of it every day. And Wagner builds power, substation, network, and distribution transformers that can supply the power you need . . . has been doing so, expertly, for over 65 years.

So, if your power needs present a critical (or even potential) problem, contact your Wagner Sales Engineer. He'll be glad to help you plan your power program, and suggest Wagner Transformers that will meet your needs for years to come.

There are Wagner branches in 32 principal cities across the country. Call the one nearest you. Soon.

Wagner Electric Corporation

6483 PLYMOUTH AVENUE, ST. LOUIS 33, MO., U. S. A.

WT60-12

VIN-COR

THE VINYL-PROTECTED CORRUGATED STEEL

* Points with Pride to

ACME STEEL Company

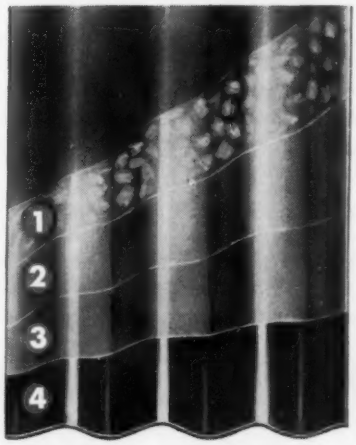
RIVERDALE, ILLINOIS

* The arrows point to Vin-Cor's maintenance-free, corrosion-resistant siding and roofing. A steel-making process as revolutionary as Acme's deserves and needs the finest and most foolproof physical plant. That's why, when it came to siding and roofing, Acme Steel specified Vin-Cor.

- **Positive adhesion characteristics in extreme temperature ranges**
- **Electronically assured specified thicknesses of vinyl coatings**
- **Vapor-barrier protection**
- **High resistance to abrasion**
- **High fire-resistance rating**
- **Unique method of having different color application on either side**

FOUR INDEPENDENT CORROSION - RESISTANT COATINGS

1 **Galvanized Zinc Coat**
2 **Bonding prime coat**
3 **Vinyl secondary coat**
4 **Vinyl finishing coat**



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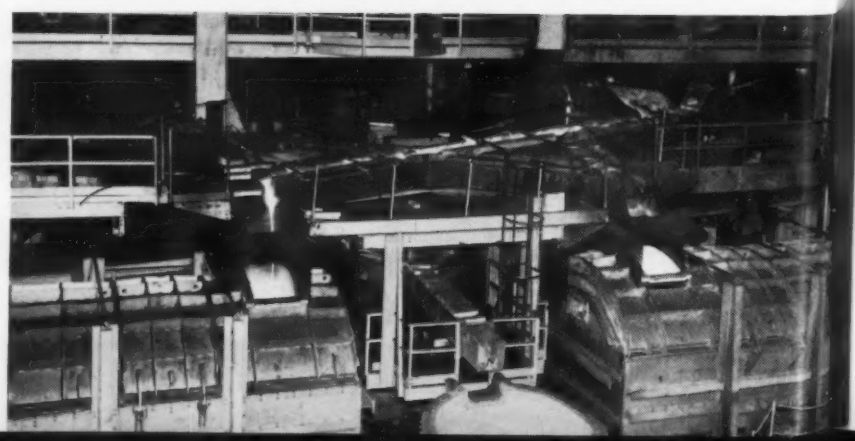
(*Above, right*) One of a pair of Acme's 30 to 50-ton oxygen furnaces. The Harbison-Walker linings, consisting of H-W MAGNESITE and H-W 17-56 brick and H-W OXIMIX monolithic refractory, holding excellent records, continue to give splendid service.

(*Below*) Two 200-ton hot metal cradle mixers. The widely used H-W brands—H-W PERIKLASE, WALSH T, VARNON BF, MAGNEX H and ANCHOR DASH—have been selected for both linings, based on highly satisfactory performance in this application.



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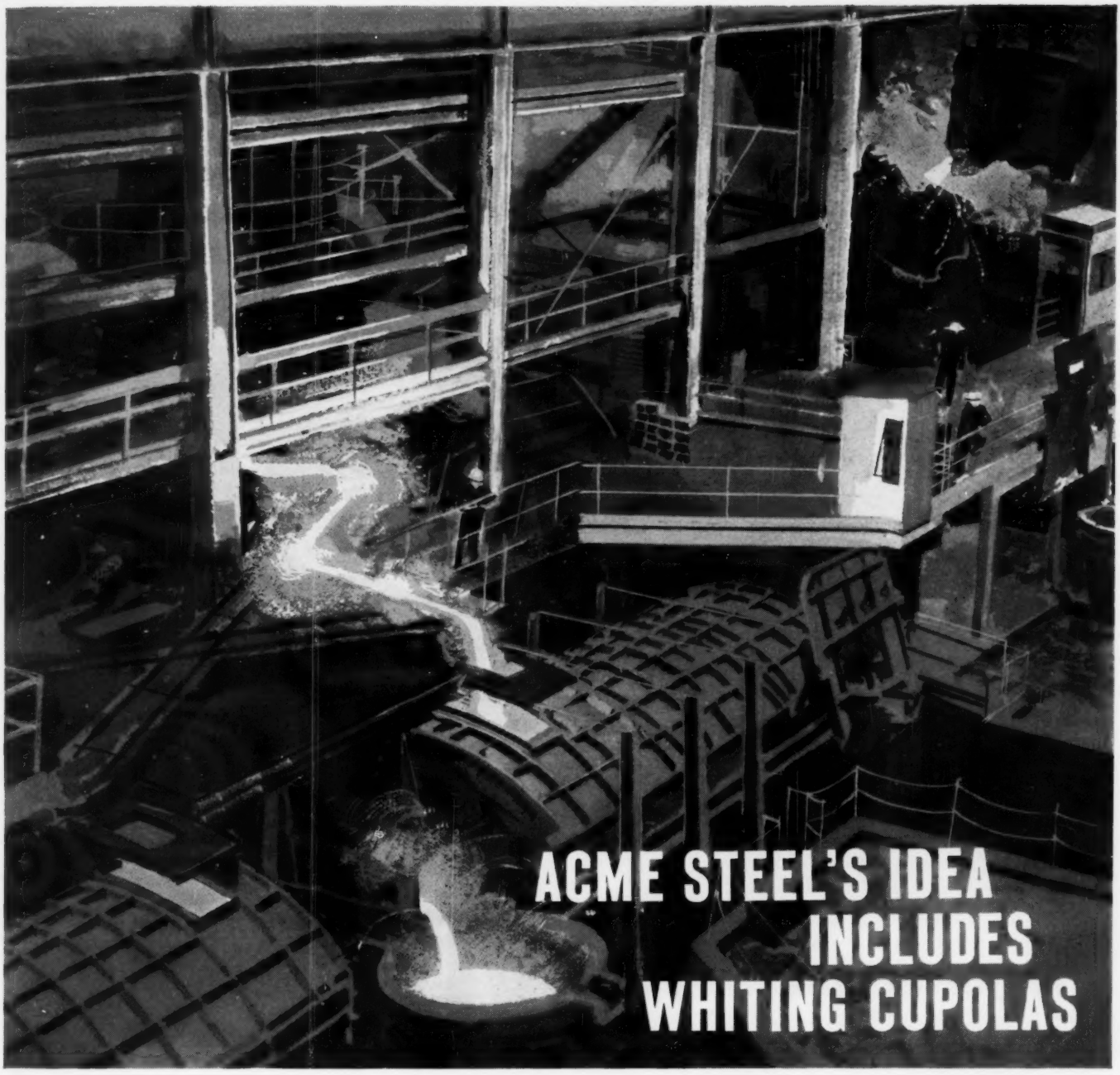

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Photo, courtesy of Acme Steel Company, Riverdale, Illinois, high-lighting new steel-making facility.

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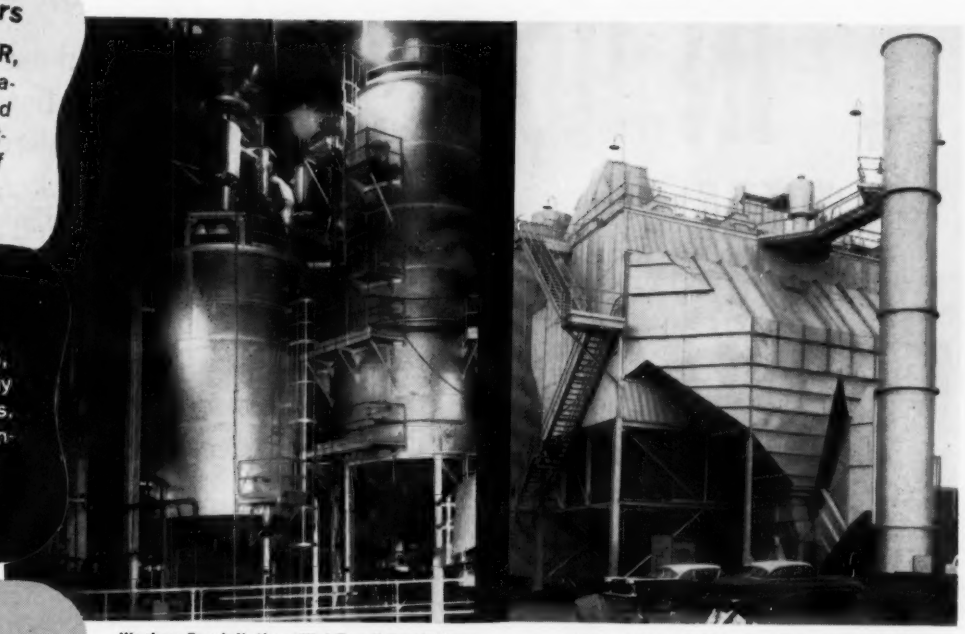

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Some Applications of COMPUTER CONTROL In The Iron And Steel Industry

by Dr. T. M. STOUT,
Manager
and Dr. S. M. ROBERTS,
Process Analyst
Process Analysis Dept.,
The Thompson-Ramo-Wooldridge Products Co.,
Beverly Hills, Calif.

Before a control computer can be installed, technical and economical justification up to the same standards as any other kind of equipment must be made . . . . the computer can be regarded as a new kind of instrument which must be capable of producing improvements in process operations sufficient to warrant the investment.

COMPUTERS for business and engineering use are now commonplace, and their capabilities are widely appreciated. The use of smaller, specially-designed, general purpose computers for process control is relatively new. In systems now being planned and installed, these computers receive data from process instruments, perform calculations to determine the best operating conditions, and transmit the results as set points to conventional controllers. A natural step in the evolution of process instrumentation, the control computer offers the hope of further improvement in plant operation.

This paper attempts to enhance understanding of computer control systems by explaining their operation, listing typical cost figures and discussing the justification for such expenditures, and suggesting some applications in iron and steel manufacture.

KINDS OF COMPUTER CONTROL SYSTEMS

Computers can assist in process control in a number of ways but not all of the applications can be called "computer control systems." Shown schematically in Figures 1, 2, 3 and 4, the possible approaches range from periodic off-line calculations to continuous closed-loop control.

An off-line application of a computer is shown in Figure 1. In a system of this kind, readings from process instruments and laboratory analyses are collected

by an operator for use in control calculations. The results of these calculations are then the basis for adjustments of process conditions. Except that the computer is usually a slide rule or desk calculator, this diagram might represent the procedure now used in making blast furnace burdening calculations. Where raw material characteristics or specifications on the hot metal do not change frequently, off-line calculations may be sufficient.

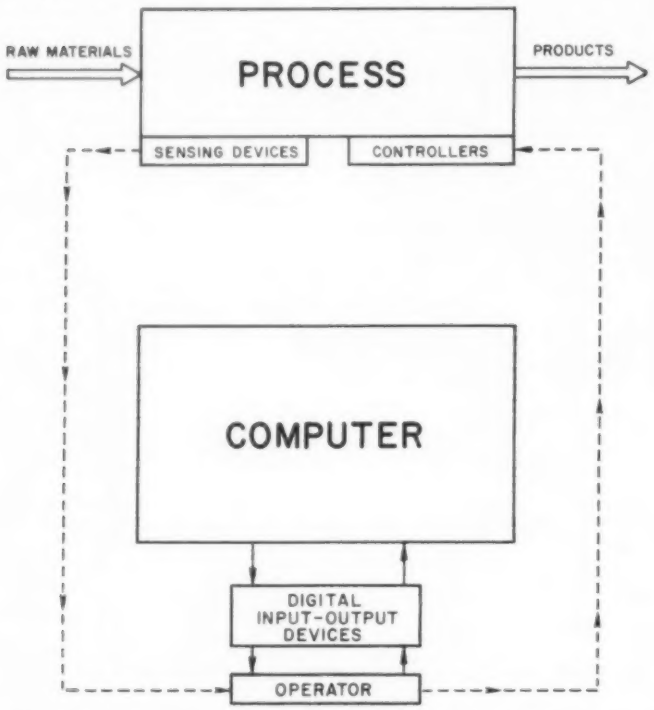
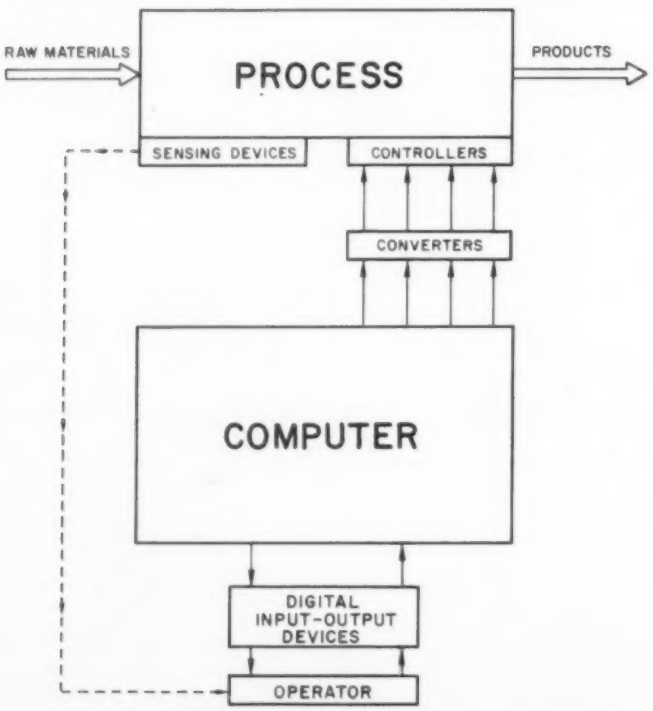


Figure 1 — A computer of this type is used for off-line control calculations. Dotted lines indicate transfer of information by an operator, solid lines denote automatic transfer of information.

Figure 2 — This computer is used as a sequence controller. Dotted lines indicate transfer of information by an operator, solid lines denote automatic transfer of information.



Use of a computer as a program or sequence controller is illustrated in Figure 2. In this application, the computer receives its information from an operator but is connected to the process so that it may exercise direct control. Various systems of this type have been installed for blooming and rolling mill control. In the simplest of these systems, a punch card may contain complete information on the number of passes, the roll speed and separation for each pass, edger speed and

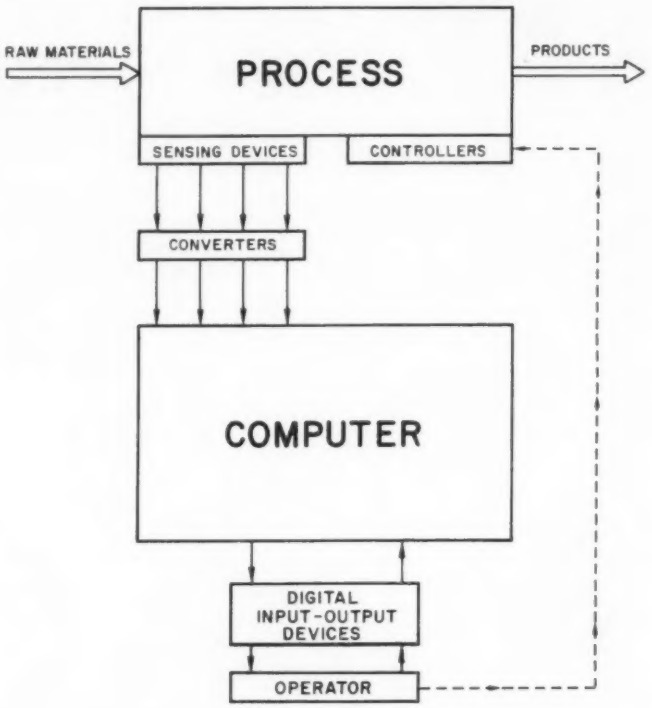
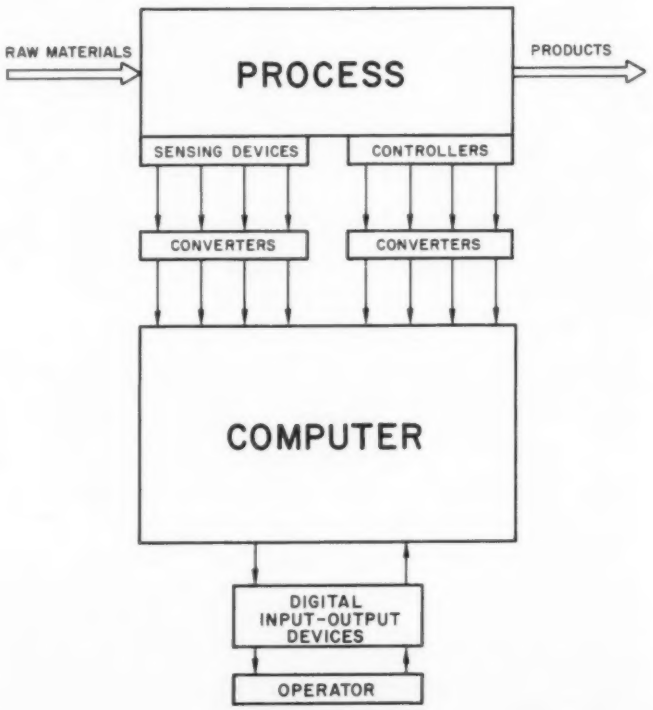


Figure 3 — Unit here can be used as a data logger and operating guide calculator. Dotted lines indicate transfer of information by an operator, solid lines denote automatic transfer of information.

Figure 4 — The ultimate objective is a closed loop computer control system.



position, etc. In more elaborate systems, the card may contain only the initial dimensions of the ingot or slab, the final dimensions desired, the initial temperature of the metal and the type of steel. By referring to its memory, the computer is expected to find a suitable mill program. These systems require a minimum number of process measurements but do not fully utilize the capabilities of a general-purpose digital control computer.

A computer used as a data logger and operating guide calculator is shown in Figure 3. Process sensing devices are connected, through converters which change the original signals into a form acceptable to the computer, directly to the computer in this system. The computer outputs are raw process data or functions of the original readings, such as yields or efficiencies which may help the operator to adjust the process to a better set of conditions. Systems of this kind have been suggested for open-hearth shops (1, 2)*. This approach is useful when process relationships are being established but, as a control scheme, it perpetuates many of the deficiencies of conventional systems.

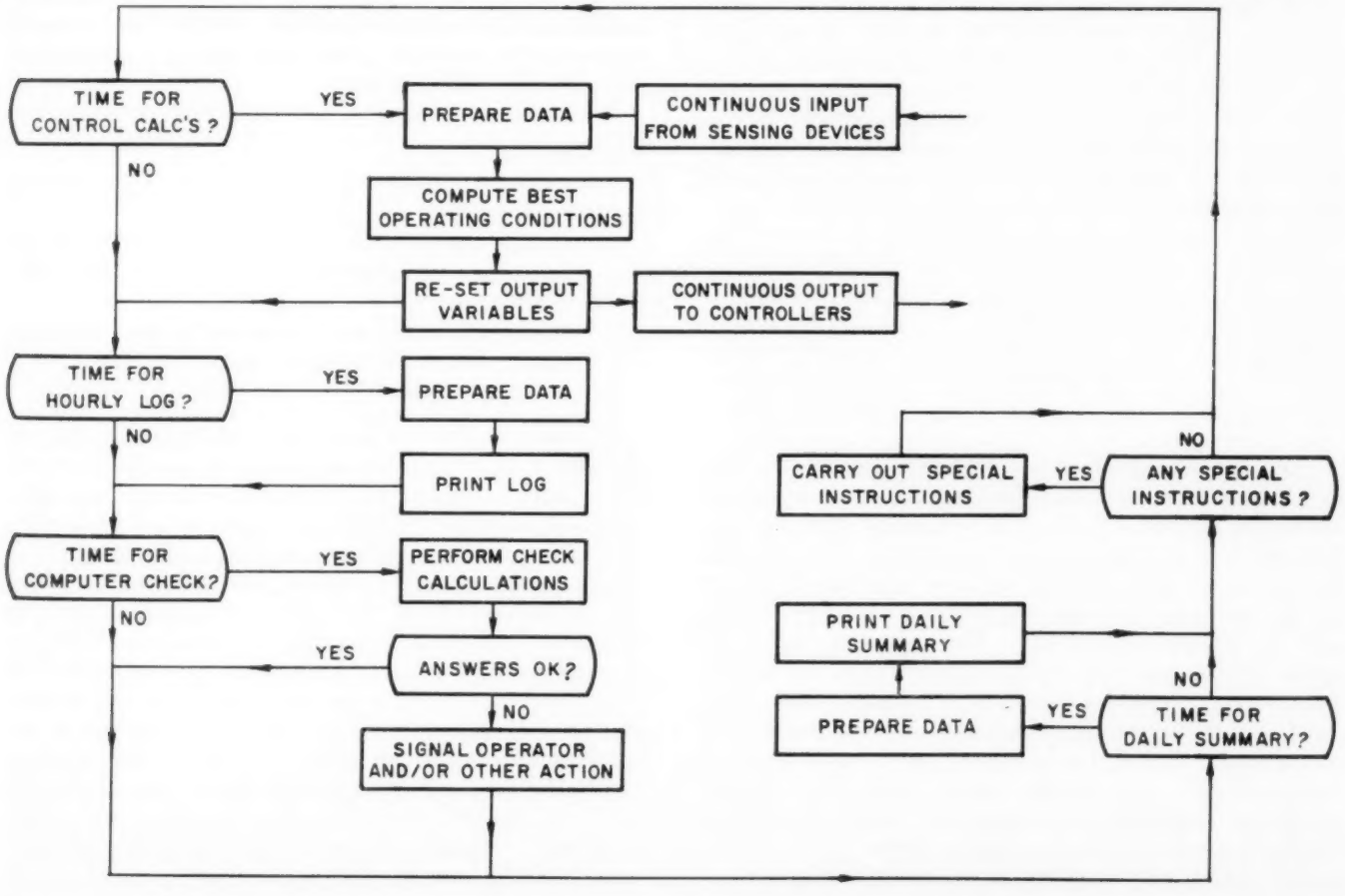
A closed-loop computer control system is shown in Figure 4. In a system of this kind, the computer reads process instruments, calculates the best operating conditions and resets the process controllers automatically. In normal operation, the operator receives data on performance of the process-computer system via a typewriter or special signaling devices and can modify system operation by inserting new constants or complete programs via a tape reader, switches or other input devices. In emergencies, the operator can assume control, running the process in the same way as before installation of the computer. A number of possible closed-loop applications in the iron and steel industry are described in the following paragraphs.

Control systems employing digital computers usually combine the functions of optimization, logging and sequence control. The various functions are executed in turn under the direction of a program of the kind sketched in Figure 5. In effect, the computer continually traverses the outside loop, watching a clock and comparing the actual time with the scheduled time for the performance of each function. When the time comes, the computer leaves the main loop, performs the appropriate calculations, resets the time at which the particular function should be repeated and returns to the main loop. The control functions generally require more time than the other functions and can be carried out in parts to allow frequent scanning for hazardous conditions. At intervals, the computer can prepare hourly or daily logs, check its own performance or carry out specific instructions. Among the special instructions can be included calibration of instruments and startup or shutdown of process equipment. These sequencing operations can be programmed if computer capacity is available and if necessary measuring and control points are provided.

Computer control systems of this kind shown in Figure 4 are valuable when process changes occur so frequently *and* the adjustments and decisions to be made depend on such complex relationships that a human operator cannot respond correctly in the time available. Random disturbances are inevitable: raw

* Numbers refer to Bibliography at end of paper.

Figure 5 — Functions of optimization, logging and sequence control are executed under a computer control program.



material characteristics, chemical compositions, equipment efficiencies, ambient conditions and product specifications change from time to time. In processes of any complexity, numerous technical relationships—usually understood only in part—and conflicting objectives make it difficult or impossible for any operator to achieve continuously the kind of performance he might be able to realize occasionally. A technical basis can be found for using a control computer in such cases, but it is also essential that dollar benefits be available which will justify the proposed installation.

ECONOMIC JUSTIFICATION

The cost of a computer control system might be as follows:

Computer	$100,000
Input-output equipment	40,000
New instruments	40,000
Process modifications	50,000
Engineering	50,000
Total	$280,000

The actual costs depends on the number of computer inputs and outputs, the number of new instruments required, and the amount of process modification necessary to make effective use of the computer. Despite uncertainties in individual items, the estimate of total costs is representative of several actual systems. Its size suggests that careful thought will be given to the advisability of proceeding with an installation of a computer control system.

As with any process improvement, the justification for installing a computer control system is found in better operation, measured in turn by increased production, higher yields, better control of product quality or reduced raw material and utility costs. As one example of the potential for justification, cost figures for a blast furnace can be examined. For a furnace producing 2000 tons of hot metal per day for 330 days, the annual raw material requirements and costs are approximately:

Material	Tons per year	Dollars per year
Iron ore	1,200,000	$14,400,000
Coke	550,000	9,000,000
Stone	300,000	900,000
Air	2,400,000	600,000
	Total	$24,900,000

A one per cent reduction in coke consumption, brought about by closer control of the furnace, would mean an annual saving of $90,000. If hot metal is valued at $50 per ton and the total raw material cost is about $38 per ton, a one per cent increase in production rate would mean an incremental earning of (2000) (330) (50–38) (0.01) = $79,000. Two per cent gains in either area, or some equivalent combination, would pay for a computer control system in two years or less.

Of course, the expected earnings of a computer control system cannot be estimated without a detailed investigation of a specific application. The figures presented above are only meant to suggest that fairly modest improvements in process operation would be sufficient to justify installation of a control computer.

POSSIBLE APPLICATIONS

Control computers may someday be applied in almost all of the processes found in an integrated steel mill. Preliminary investigations directed toward such installations have already started. While the temptation is great to offer some comments on possible applications to all of the steel-making processes, space problems limit discussion here to a few illustrative examples.

Sinter plants—Schuerger (3) has described a computer control system for a sintering plant which controls machine speed and raw material feed rates so that burn-through occurs at a specified position near the discharge end of the grate. Two principal functions are performed in this system. Using data from wind box thermocouples, an analog computer determines the point of maximum temperature or the burn-through position, compares this position with a set point and furnishes a feed-rate reference to a feed control system. Sinter fines or "hot recycle" is fed on level control, and further calculations determine the amount of ore, coke, flue dust and water that must be added to give the required total feed rate and feed composition.

Although the proposed system uses analog computing equipment, the calculations are intermittent; feed rate changes are made periodically at an interval equal to the time of travel from one end of the grate to the other. A digital control computer probably could not be justified solely for a sinter plant, but it might reasonably perform functions like those described on a part-time basis in connection with some other application.

Blast furnaces—Control of a blast furnace consists of two separate but related functions: charging the right materials at the top of the furnace, and maintaining the proper conditions within the furnace. A computer control system might contribute to better furnace operation in both areas.

For accurate control of raw materials entering the furnace, three requirements must be satisfied:

1. Chemical and physical characteristics of the materials must be known.
2. Burdening calculations must include all of the important considerations and be accurately carried out.
3. Raw materials must be charged to the furnace in close conformity with the results of the burdening calculations.

In many mills, raw material characteristics are not measured as frequently as a control engineer would like; daily, weekly or even monthly averages, generally obtained after the material has been used, often constitute the only information available. Unfortunately, obtaining more precise data on the chemical and physical properties of the materials could well require an elaborate system of sampling and analysis. Such an investment of money and effort is not easily justified in the absence of data on the extent and importance of raw material variability. Better satisfaction of requirements (2) and (3) above, however, could demonstrate the need for better knowledge of the raw materials. A control computer can provide more exact burdening calculations and see that amounts charged agree with the calculated amounts.

Burdening calculations are now made manually, using a desk calculator or slide rule, and are necessarily simplified. More comprehensive calculations could be made. It is possible to write equations expressing the part played by each material in meeting requirements for hot metal production, total slag volume, base-acid ratio, coarse-fine ratio, sulphur and phosphorus content of the hot metal, and so on. By use of linear programming techniques, exact values or upper and lower limits can be specified, and least-cost selections of raw materials can be made with various kinds of restrictions on their availability (4, 5). Analyses of this kind are not practical for hand calculation but can easily be done by a control computer.

In a conventional stock house, using a hopper to weight coke into the skips and a scale car to collect and weigh ore, limestone and other materials, simple modifications of the scales and installation of a control computer would permit greatly improved control of blast furnace charging. Indicating devices under computer control could direct the scale car operator to take XXXX pounds from bin YY, following a schedule supplied by the furnace supervisor or calculated by the computer itself, and could receive a signal from the scale showing the weight actually loaded. This sequence would be followed for each of the materials used. On subsequent loads of a given material, accumulated overages or shortages would automatically be included, as would any request for temporary burden changes from the furnace supervisor. The weight figures transmitted to the scale-car operator would allow for the moisture content of the raw materials. By a system of this kind, numerous sources of error in burdening would be eliminated; better data on the furnace charge would become available; and better furnace operation should follow. For a modern automatic stock house, a similar scheme could be used, the control computer being used to direct and verify operation of weighing feeders and conveyors.

Even with close control of the materials charged at the top of a blast furnace, an important problem remains in the regulation of furnace conditions by adjustment of blast rate, temperature, moisture content and pressure. These variables (and others, not so directly controllable, such as iron, slag and tuyere zone temperatures, or top gas pressure and temperature) have an important bearing on the hot metal production rate, product quality and coke consumption. A choice of process conditions giving the best economic balance between these objectives can only be obtained if furnace behavior is predictable. If equations can be written to express—for example—the disposition of sulphur in the charge to the hot metal and slag as a function of furnace conditions, these equations can be solved backwards to develop control relationships. Because of knowledge already available on furnace behavior (6, 7) a good start can evidently be made in this direction. Data obtainable through the logging capabilities of a control computer will permit verification and modification of approximate relationships (adopted as a starting point) before they are used for control. Additional data collected while the system is operating can be used to bring the relationships up to date. Through this evolutionary procedure, a control scheme can be developed which should effect significant improvements in blast furnace performance.

As a large and critical unit in a steel mill, the blast furnace is a good candidate for computer control. Some work has already been done in this direction (8, 9).

Open hearth—The open hearth furnace presents a real challenge to the computer control system designer, partly because of the materials handling problem involved and partly because of the batch nature of the process. Studies of open hearth operation have indicated that a sizable fraction of the tap-to-tap time can be attributed to delays in the arrival of ladles and scrap buggies, and that even without delays much of the time is spent in furnace charging. Improvements in material handling would therefore contribute significantly to better operation.

The ideal solution of the material handling problem might be a drastic rearrangement or expansion of existing facilities, or perhaps introduction of a completely different type of charging system. While these changes might be desirable from an operating viewpoint, they are less attractive from a cost viewpoint. It is possible, however, that the problem can be attacked from another angle and a solution obtained which is satisfactory on both counts. If it reduced the chance of bunched heats and consequent demands that the ladles and scrap buggies be several places at once, a computer control system might make an indirect but important contribution to smoother operation at a reasonable cost.

Control of an open hearth includes the same two functions that were discussed in connection with the blast furnace: charging the right materials to the furnace and maintaining the proper conditions within the furnace. Since the open hearth is a batch process, the timing of control actions is another important consideration. The control computer can be helpful in all three areas.

As one of its jobs, the control computer might be programmed to make a least-cost selection of raw materials meeting the composition requirements for individual heats. With scrap as an additional raw material and with frequent changes in steel specifications, calculations of this kind are more valuable at the open hearth than at the blast furnace. When operational considerations do not allow this degree of flexilibity in the proportioning of raw materials, the computer can still calculate the amounts of the significant elements in the charge from a knowledge of the weight and analysis of each of the raw materials.

Objectives of open hearth operation might be stated as producing steel of a specified composition at a suitable temperature for casting in a minimum time or, alternatively, producing steel at the desired composition and temperature for casting in a specified time at minimum cost. An open hearth might be controlled to meet such objectives in either of two ways. In the simpler of the two schemes, the computer would be expected to develop the tap-to-tap cycle from a set of basic equations. These relationships, developed from past operating data, might express such properties as bath temperature, carbon and phosphorus content at tap time, etc., as functions of the amounts and kinds of materials charged, the Btu input, roof temperatures and furnace pressure at various times in the cycle. In effect, the "best" cycle for each heat would be interpolated from equations summarizing practices which

have proved successful in the past. A computer used in this manner would provide an unlimited variety of furnace cycles, each tailored to an individual furnace charge.

In a more sophisticated approach, the computer would be provided with information on the progress of the reactions periodically during the refining portion of the heat. By means of some approximate kinetic equations, containing rate constants which are modified to fit the observed history of the heat, the computer would determine the future program of fuel variation needed to reach the desired steel composition in minimum time or at minimum cost. It might also direct addition of limestone, mill scale or other materials. The necessary observations and calculations would be repeated at, say, ten- or fifteen-minute intervals. The last approach has been successfully applied by D.P. Eckman, I. Lefkowitz and their associates at Case Institute who developed the measurement and computation techniques needed for control of a batch hydrogenation process (10). By varying the reaction pressure, in accordance with the general scheme described above, the time required to reach a desired product composition was reduced substantially. In an open hearth, the ability to reach a desired composition and temperature for tapping at a prespecified time might be equally valuable since it would permit accelerating heats or holding them back slightly to avoid bunching.

The general approach just discussed was suggested in 1949 by Robertson and Thring (11). Additional research and the arrival of the digital control computer may now have made it a practical means of control.

Rolling mills—In blooming mills, a control computer might be used to calculate the reduction to be made in each pass on an individual basis tailored to the characteristics of the metal being rolled. The initial mill setting might be based on the nominal ingot dimensions, temperature and metallurgy. After each pass, subsequent settings could be calculated so that the slab is rolled to its final dimensions in a minimum number of passes (odd or even as necessary to finish on the correct side of the mill), using measured mill forces and roll separations as a guide to the reduction that can be made in following passes. Roll and table speeds, guide positions, manipulators and sprays could also be controlled. More flexible than a completely preprogrammed punch card mill control and capable of using more complex control relationships than the human operator, a control computer should do a better job of rolling steel at mill capacity while reducing the chance of equipment overloads.

Draft calculations for a roughing mill follow a similar pattern except that the number of passes is fixed. An added complication is found in the possibility of slabs of different sizes following each other in rapid succession through the mill. Signals from hot metal detectors can be transmitted to the computer and used to track slabs from one stand to the next. When the computer detects that the back end of a slab has passed through any stand of the roughing mill, it will quickly check to see if the roll separation should be changed for the next slab. If a change is necessary, the new separation will be obtained from the computer memory where previously-determined values have been stored. The roll separation can be calculated for each order by the computer to fit the initial slab dimensions and the thickness desired leaving the final stand.

If the roughing mills are driven at constant speed, only the roll separations need to be calculated. The nominal settings can be found by a series of simple calculations. If the reduction in each stand is defined by

$$r_1 = \frac{h_1 - h_{12}}{h_1},\ r_2 = \frac{h_{12} - h_{23}}{h_{12}},\ r_3 = \frac{h_{23} - h_{34}}{h_{23}}$$

and so forth, the ratio of the final slab thickness to the original slab thickness is

$$\frac{h_5}{h_1} = (1 - r_1)\,(1 - r_2)\,(1 - r_3)\,(1 - r_4)\,(1 - r_5)$$

To calculate the various r's for given values of h_1 and h_5, it is necessary to specify some additional conditions. These conditions might be stated as

$$r_1 = r_2 = r_3 = r_4 = r_5;$$

or

$$r_1 = 0.4,\ r_2 = r_3 = r_4,\ r_5 = 0.2;$$

or

$$r_1 = r_2 = r_3 = 2r_5,\ r_4 = 1.5r_5;$$

or in some other equivalent fashion. The first condition specifies that equal reductions are taken in all stands; the second condition fixes the reductions in the first and last stand, the reductions in the middle stands being determined by the over-all reduction; the third condition expresses all reductions as multiples of r_5. The reductions for individual stands can also be calculated from more complex relationships if necessary.

Having determined the reduction to be taken in each stand, the roll separations are easily determined:

$$\begin{aligned} s_1 &= h_{12} = h_1\,(1 - r_1) \\ s_2 &= h_{23} = h_{12}\,(1 - r_2) \\ s_3 &= h_{34} = h_{23}\,(1 - r_3) \\ s_4 &= h_{45} = h_{34}\,(1 - r_4) \\ s_5 &= h_5 = h_{45}\,(1 - r_5) \end{aligned}$$

If necessary, the nominal roll separations computed in this manner can be modified to allow for roll deformation or mill stand deflections.

Calculations for a finishing mill are similar in nature to those for the roughing mill. However, because speeds must be co-ordinated in order to maintain the proper tensions between stands, additional calculations are needed to give nominal speed settings for each stand. (It is expected that these settings will be "trimmed" by a continuous gage control system which corrects for changes in thickness produced by temperature or metallurgical variations along the slab).

The reductions in the stands are calculated from

$$\frac{h_7}{h_1} = (1 - r_1)(1 - r_2)(1 - r_3)(1 - r_4)\,(1 - r_5)(1 - r_6)(1 - r_7)$$

for a seven-stand tandem mill. As with the roughing mill, relationships between the reductions must be specified before exact values can be found. If, for example, it is specified that

$$r_6 = 1.5\ r_7;\ r_5 = 2.2\ r_7;\ r_4 = 3\ r_7;\ r_3 = 3.5\ r_7;$$
$$r_2 = r_1 = 4\ r_7$$

solution of the above equation for the $h_7/h_1 = 0.1$ gives

$$r_7 = 0.099$$
$$r_6 = 0.149$$
$$r_5 = 0.218$$
$$r_4 = 0.298$$
$$r_3 = 0.347$$
$$r_2 = 0.397$$
$$r_1 = 0.397$$

This example illustrates the derivation of a feasible schedule of reductions, in accord with accepted mill practices, from a fixed equation which can be adapted to fit changing input thicknesses and finish gages. It might be emphasized that the ratios between the reductions are arbitrary and that other ratios might be substituted. Following installation of the computer control system and collection of data on mill performance, more sophisticated procedures might be introduced such as calculation of reductions to give a minimum total power requirement for the mill drive, to load the drive motors in proportion to their ratings, etc.

After calculation of the reductions in each stand, the thicknesses can be calculated as discussed in connection with the roughing mill. With the thickness figures available, the linear velocities of the slab leaving each stand are figured from the following relations:

$$h_1 v_{12} = h_{23} v_{23} = h_{34} v_{34} = \ldots = h_7 v_7$$

The delivery velocity from the seventh stand (v_7) is specified in advance, and the other speeds depend only on the thicknesses. After the linear velocities are determined, the roll speeds can be computed. If it is assumed that the roll speeds are fixed by the linear velocity of the slab on the delivery side of the stand, the necessary equation is

$$\omega = \frac{v}{\pi d}$$

where ω is expressed in rpm, v in fpm, and d in ft. Since roll diameters change as a result of wear and variations in roll temperature, roll speeds will be calculated more accurately from a relation of the form

$$\omega = kv$$

where k is a "constant," different for each stand, which is determined from measurements of the actual motor speeds and slab thicknesses during the rolling operation. These measurements are one facet of the continuous mill monitoring which can be carried out by a control computer.

DIFFICULTIES

Application of computer control techniques in iron and steel manufacturing processes will not be easy. Considerable effort will be needed in developing the equations needed by the computer, and means will have to be found for measuring process conditions. New knowledge and equipment, plus reports of successful solution of similar problems in other industries, permit a feeling of confidence that these tasks can be accomplished.

An important and difficult aspect of any system design is the development of relationships between the process variables. These relationships can take many forms but must be adequate for prediction of process performance as the independent, controllable variables are changed. These relationships can be theoretical or empirical, but they are best developed by a combination of theory and operating data. Theory indicates what variables are involved and the form of the functional relationships, while operating data permits evaluation of parameters which are not easily fixed by theory. Such parameters can be up-dated from process measurements by the control computer after it is placed in operation.

Processes for the manufacture of iron and steel present some formidable problems in this area. Knowledge of the fundamental chemistry of blast furnace and open hearth operation is growing but may still be inadequate; a wealth of empirical data is available, however, which might serve as a starting point for design of a computer control system. The new L-D or basic oxygen process is perhaps more easily instrumented and controlled, and it may be a better candidate for computer control than the older processes. Work on the effects of rolling mill variables by Hessenberg and Sims (12), Phillips (13), Courcoulas and Ham (14) and others has done much to put recognized interrelationships on a quantitative basis.

As part of his job, the designer must ascertain that variables essential to the control scheme can be measured. Where suitable instruments are not available, alternate means of obtaining the required data must be devised.

Many of the measurements needed in steel mill applications—such as gas flow, weight, force, pressure, speed and gage—are routine. Other measurements—such as hearth temperatures, metal composition and top gas analysis—have not reached such a high state of perfection (15–17). In some cases, the control computer may alleviate measurement problems. For example, if local conditions permit measurement of blast rate and top gas analysis but not the top gas rate, a nitrogen balance might be used to calculate the top gas rate and hence the amount of carbon in the top gas as a check on the coke rate to the furnace.

Difficulties of mathematical relationships and instrumentation have been met in other industries by cooperative studies carried out by representatives of the computer user and the manufacturer. As would be expected, the first group supplies an intimate knowledge of the particular process under consideration, as well as a general background in the technology of the industry, while the second group furnishes specialized abilities in planning and installing computer control systems. Because of recent advances in the art and science of making iron and steel, the two groups may now find it possible to solve the problems which are encountered in design and evaluation of computer control systems.

SUMMARY

While widespread application of digital computers for control of industrial processes has been predicted by many people, installations will not be made merely to be fashionable. It is expected that technical and

economic justification will be demanded, with the control computer required to meet the same standards as any other kind of new equipment.

Technical justication for the use of a control computer is found in its ability to deal quickly, accurately and uniformly with events causing or necessitating a change in process conditions. This capability permits a departure from the present concept of control, summarized very concisely by A. G. Green. Discussing the question of whether color or alum should be added first in coloring paper stock, he wrote (14):

". . . The practical way of running a mill is to have a fixed rule, one that is nearest right on the average, and one that will not involve a lot of men in the complexities of chemistry."

With a computer to handle "the complexities of chemistry" compromises of current control practices become unnecessary. Instead of simplified rules, charts and nomographs now supplied to process operators, the computer will use relationships whose complexity is limited by the ingenuity of the system designers. Instead of following fixed patterns or trying to hold constant conditions that are "nearest right on the average," the computer will vary its actions to match changes in feed characteristics, product specifications, equipment efficiencies and ambient conditions.

Nobody should expect that introduction of a computer will bring process operation to a hitherto unattainable state of perfection. Measuring and control devices associated with the computer are not perfect, and the mathematical relationships employed can only reflect current knowledge of the process. Rather, the computer should be regarded as a new kind of control instrument, capable of producing improvements in process operation sufficient to warrant investment in the control equipment.

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Discussion

PRESENTED BY

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R. W. Kirkland: The digital control computer is obviously a new, novel and important automation tool and it will affect the working lives of all of us.

My own company is now at work on four digital control computers for installation in the steel industry. No one has a great deal of operating experience with these machines, but we know that process control, using machines of this sort, requires a numerical description of the process before the process can be controlled. The computer itself is not capable of original thought, however many mills are now being successfully run by operators who occasionally have the same deficiency. This being so there is a place for control computers. The computer must be told in complete detail precisely what it is to do. It is clear from this that the process to be controlled has to be changed from an art to a science before a digital control computer can be used.

I notice Dr. Stout's tabulations include $50,000 for systems engineering. I would like to ask Dr. Stout if this includes the process study required to develop the process mathematics and the computer program?

Another question, could you tell us what method you have used or propose to use to take care of noise from the system sensing devices and I would like to know if you have found this sensor noise troublesome in any of your operating installations?

Dr. T. M. Stout: I agree that the computer is not capable of original thought. It has to be told very pre-

cisely what to do. I was asked if the $50,000 in the cost breakdown included the study of the process necessary to write the control relationships. Part of that figure is for this purpose. Some more of the cost of the systems study is buried away in the cost of the computer itself.

The question was also asked how do we deal with noise? By noise, we refer to the random variations that are present in any sort of measurement. Some of this is handled by taking averages of readings. Some of the higher frequency variations are handled by electrical filtering of the signals from the measuring devices.

Irving Rozian: I was particularly glad to hear Dr. Stout mention the blast furnace. At Ford we have been engaged in a two-year study of computer control for the blast furnace. We have some accumulated experience now and some pertinent questions.

The approach that we are taking is to study process dynamics in the course of factorial experiments on practice and raw materials. We are taking data on a number of inputs and outputs at intervals as close as 15 minutes in some cases and hourly in others.

Statistical methods must be used in analyzing the data because of uncontrollable variations present in the raw materials and other process conditions. We plan to run partial and multiple correlations to get an outline of the equations which might describe the process sufficiently for control.

We want to design a control system, based on our mathematical model, which will give the maximum amount of iron at the minimum coke rate with the least variations in sulphur and silicon.

However, even when one has a mathematical model for the normal conditions, there are serious problems remaining. One of these is how to handle the off-limit conditions. For example, one might find a function describing the trend of production versus wind rate for a furnace. But at some particular wind rate the furnace will begin to hang and kick. A limit has been reached and a discontinuity encountered in the function.

A second problem is the long time lag between raw material charging and analysis of the product. The charging is six to ten hours ahead of the cast, and the total time may be fifteen hours before the laboratory results and iron weights come back.

Still another problem is unequal driving rates on opposite sides of the furnace. In other words, the furnace may be a nonhomogeneous reactor with variable hold-up time.

In the light of these problems of discontinuous functions, long time lags and nonhomogeneity, I would like to ask Dr. Stout how he plans to close the loop for feedback control?

It appears to us that a possible approach might be the use of feed-forward forecasting for short-range process corrections, with feedback employed only to correct for longer-range trends. Would Dr. Stout please comment on this idea?

Dr. T. M. Stout: Mr. Rozian has presented very forcibly some of the difficulties I spoke of. I recognize that the blast furnace presents both continuous and batch aspects: the material charge is more or less continuous, but the product is withdrawn at four or five hour intervals. There is some averaging in the furnace for this reason.

I think as a starter, at least, that you might adopt the stand that the material leaving the furnace at any particular cast was charged, say, during the interval between the two previous casts and that the conditions applied to it are some sort of summation of temperatures, blast rate and moisture, and other variables over the intervening six to ten hours. This is the way I would start to develop a sort of simplified model to represent the holdup in this process. I recognize that this model will not be an exact representation. Some materials are going to sift through the furnace pretty rapidly, and others will get stuck and won't come out for several casts, but I think this is a good place to begin.

Now he also spoke of the desirability of making the maximum amount of iron at the least cost and the minimum variations in silica and sulphur. To put it in the vernacular, this is the most of the best for the least. I would like to suggest that ordinarily you cannot satisfy as many objectives as this at one time. You can have the maximum iron at whatever cost is involved and at a specified quality in keeping with limits imposed on the concentrations of silica and sulphur. You can also make a specified amount of iron at a minimum cost. In general, you cannot simultaneously have the most and the least expensive. In making these statements, I am thinking of the *total* cost of raw materials, utilities, and so on; it is probably true that the minimum *unit* cost of iron from a blast furnace is attained simultaneously with the maximum production rate. This hair splitting illustrates nicely the fact that setting up the objectives for a control system is a rather difficult problem in itself.

Another question concerned the use of feed-forward and feedback techniques in a computer control system. We have frequently proposed feed-forward control based on measurements of raw material quality or quantity and a mathematical model by which the best process conditions can be calculated, with measurements of product quality or quantity being used in a feedback manner to correct parameters in the mathematical model. This technique appears to be a powerful one, well adapted to the blast furnace control problem.

Stephen Vajda: In regard to Dr. Stout's statement, "Let us proceed unhampered by facts," I do not know what the boss would say about that. He presented the desirability of a computer on three arguments; one that you would be able to control the charge into the furnace. I am just wondering if we are not trying to get the cart before the horse, in that, unless we can develop some accurate sensing devices that will give us the analysis almost continually, all of our other efforts are worthless.

For instance, a check of the heat consumption in the furnace shows that the heat required to melt the ore is not much different than the heat required to melt the slag. Thus the blast furnace, if you feed it a fixed amount of coke, actually does not care if you are feeding it ore or gangue. It shows up in the result where you have a different amount of slag versus your iron.

His second reason for using the computer on the blast furnace was that you could go into more elaborate computations. That is a little, I think, like putting the micrometer on the end of a yardstick. If you do not know what the analysis is on the material, there is not much point in getting into more detailed calculations.

His third point was that you could schedule the material being put into the furnace more accurately. I think we have accomplished this in our modern day blast furnaces up to about 90 per cent with our automatic stock houses, with our conveyor belts and weighing scales. At the present this does not seem to be too much of an incentive.

Dr. T. M. Stout: I think I am expected to rise to the bait presented by Mr. Vajda. He made some comments on three of the points I made in connection with charging. The question was, can you really charge a furnace until you know the material analysis? Our thought on this was the other way around. We have heard a number of people suggest that the present knowledge of material characteristics is quite adequate for blast furnace control. As a check on this, we propose to totalize the amounts of material that go into the furnace, using the compositions that are now used, to see whether this really permits any prediction as to what happens in a furnace.

Another comment which was made was that additional calculations which are possible with a computer would not be useful until greater knowledge of the materials and also the furnace is available. This may very well be true.

I think that there are aspects of charging which are now understood, and are not part of the ordinary calculations. Rather, relationships are available that are not considered when the operator decides he needs a pinch more of this or a pinch less of that. Some of these decisions could be put on a more qunatitative basis.

He also suggested that the control of charging would be better accomplished with the automatic stock house. I agree. The comments I made were particularly concerned with a conventional sort of stock house where the computer, its data gathering facilities, and its ability to direct an operator might be regarded as some sort of substitute for the conveyors and other devices that made up an automatic stock house. A control computer might also be used in conjunction with an automatic charging system to calculate what should be charged and to make other control calculations.

Irving Rozian: Just one brief additional comment. The papers on what the Russians have done in the field of automatic computer control of blast furnaces indicate that their first attention has been devoted to just these questions of calculating and trying to stabilize the materials charged to the furnace. They have also gone to rather elaborate systems for controlling the distribution of material going into the top.

Ray J. Stanish: During the past two years I have visited quite a few process plants—chemical, oil refining, steel, synthetic rubber, you name it—in an attempt to interest them in closed-loop computer control systems. In practically all cases, operators have contended that their process was an art and not a science, that it was not reducible to mathematics and, therefore, not adaptable to computer control. This overly modest admission of lack of process know-how frightens me from purchasing almost any product.

Yet these plants are operating and have been operating profitably for years and turning out salable products. I am forced to conclude, therefore, that we know much more about these processes than we take credit for. Admittedly we all wish we knew more, however.

Another obstacle to computer control is the reported lack of adequate instrumentation. When computers first appeared years ago, they were referred to as "giant brains." We have come to think of them as being infallible and have concluded erroneously that all aspects of a computer system had to be "perfect" or there was no future in considering the installation of a system. Actually, although it is not "perfect," in most cases the available instrumentation is "adequate" for computer control.

But, the principal logic behind the use of a computer to control a process is that irrespective of the lack of precision with which variables are measured, the ability of a computer to manipulate the data rapidly and consistently is so superior to that of a human being, that some improvement in the operation of the process is inevitable. Naturally, the improvement will be greatest when the mathematical model of the process is known to the fullest degree and when ideal instrumentation exists.

But, if room for improvement exists in the operation of the process, the process is understood reasonably well, and the instrumentation is adequate, then a computer control system can be a profitable investment.

J. E. Oram: We most certainly agree that there are a number of processes in the steel plant which can benefit materially from the application of computer control techniques, or what I would call "process direction."

Contrary to the author's general conclusion, however, our analysis indicates that the sintering process offers an excellent opportunity for application of "process director" systems, and that these systems can be economically justified. As a matter of fact, one of our first applications of the digital computer in the steel industry is on a sintering plant.

The authors have also mentioned the possibility of performing raw materials "charge" calculations for the blast furnace with an on-line digital computer. One of the primary missing links in such a system, has been, of course, a means of obtaining frequent, accurate, "on-line" chemical analysis of available raw materials.

This need has now been fulfilled by a new "on-line" x-ray emission gage developed and recently announced by my company. This new gage has been developed specifically for such processes as the blast furnace, sintering plant, open hearth, etc. As a matter of interest, the first of the new gages will be used in conjunction with the sinter plant computer system mentioned above.

I believe the next few years will see tremendous strides toward "process direction" of many of the processes of the steel plant. The digital computer will be an important element in these systems.

Dr. T. M. Stout: In a cement plant application of our computer which I spoke about, an x-ray spectrometer is being used to analyze raw materials. At the present time the transfer of data from the analyzer to the computer is made manually. However, the design of the instrument is such that a direct connection could be made if you so desired. The raw materials used in cement manufacture are similar to the ones used in blast furnaces as I have already indicated. The x-ray spectrometer is another new tool for your consideration. ▲

A Modern High Speed Tandem Cold Reduction Tinplate Mill

. . . . high speed tinplate mills require automatic gage control . . . . many gage control schemes are available, each with its advantages and disadvantages . . . .

by NELSON W. HOCKING, JR.
Chief Plant Engineer*
Wheeling Steel Corp.,
Yorkville, Ohio
and ALONZO F. KENYON,
Advisory Engineer
Industrial Engineering Dept.,
Westinghouse Electric Corp.,
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THE new five-stand tandem cold reduction strip mill which was put into service at the Yorkville, Ohio, plant of the Wheeling Steel Corp. during December, 1957, incorporates the most modern mechanical and electrical features for the efficient and economical production of thin tinplate strip, and enables the Wheeling Steel Corp. to continue as a leading producer of quality cold reduced tinplate.

This steel company pioneered in the cold reduction rolling process for tinplate with the installation of the first tandem cold mill in 1928, followed by larger, faster, and higher powered mills in 1934 and 1937. Table I shows the progressive development in this one plant from the 1928 mill of four 32-in. stands geared for 340-fpm maximum speed and with 1020-hp total mill and reel drive motor capacity, to the new 1957 mill of five 48-in. stands geared for 6050-fpm maximum nominal speed and with 22,500-hp total drive motor capacity. Note however that with this twenty-fold increase in rolling speed and total drive capacity, the unit drive capacity expressed in horsepower per 1000 fpm per in. roll face has remained about the same. The expected large output from the new No. 3 mill made possible by the high rolling speed, high acceleration and deceleration rate, automatic controls and large coil size, will exceed the combined output of the two older 42-in. mills No. 1 and No. 2 so that one of them will be removed and the other retained and operated only for rolling special orders.

DESCRIPTION OF MILL

The new No. 3 tandem mill Figure 1 consists of five stands spaced on 14 ft-0 in. centers. The backing rolls are 53 in. nominal diameter and are supported in oil sleeve bearings. Initially the working rolls are 21 in. nominal diameter with 48-in. face to enable rolling strip up to about 42-in. maximum width, however the mill is designed to permit the use of 23-in. maximum diameter rolls, also to permit the use of 51-in. face rolls to produce strip up to 45-in. maximum width. The working rolls are carried in grease lubricated roller bearings. The mill housing posts are 952-sq in. cross-section, and each of the ten housings weighs about 114 tons.

The winding reel is spaced 12 ft-7 in. from the No. 5 stand, with 20½-in. diameter wedge type expanding mandrel and suitable to handle coils up to 72-in. maximum outside diameter, 45,000-lb maximum weight. Figure 2 is a closeup view of No. 5 stand and the reel showing a finished coil on the delivery conveyor and another coil winding on the reel.

Coil handling at both the entry end and the delivery end of the mill is almost completely mechanized. Coils

TABLE I
Development of Tandem Cold Reduction Mills

Mill Designation	..	No. 1	No. 2	No. 3
Year installed	1928	1934	1937	1957
Mill width, in.	32	42	42	48
Number of stands	4	5	5	5
Maximum speed, fpm	340	1080	1210	6050
Total capacity of mill and reel motors, hp	1020	4150	4900	22,500
Unit capacity, hp per 1000 fpm per in. roll face	93.9	91.5	96.5	77.4

* At time of paper presentation, now Superintendent of Maintenance, Wheeling Steel Corp. Steubenville, Ohio

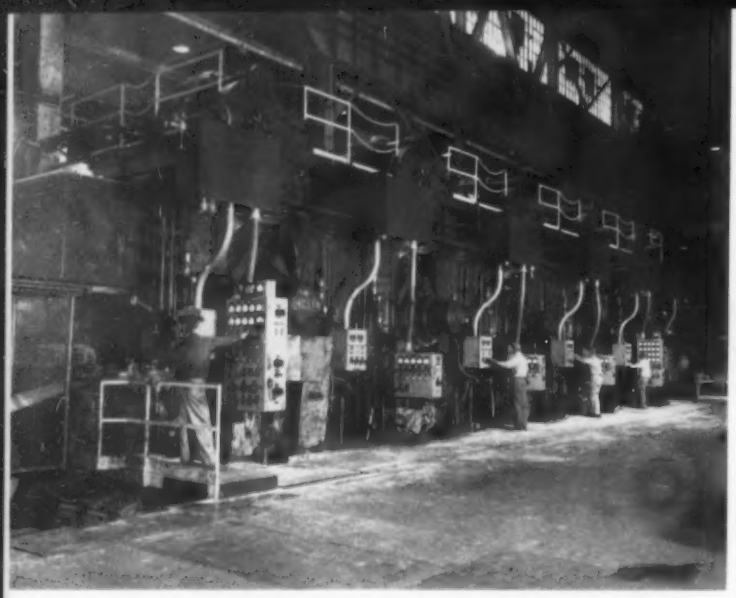


Figure 1 — General view of 48-in., 5-stand tandem cold reduction strip mill.

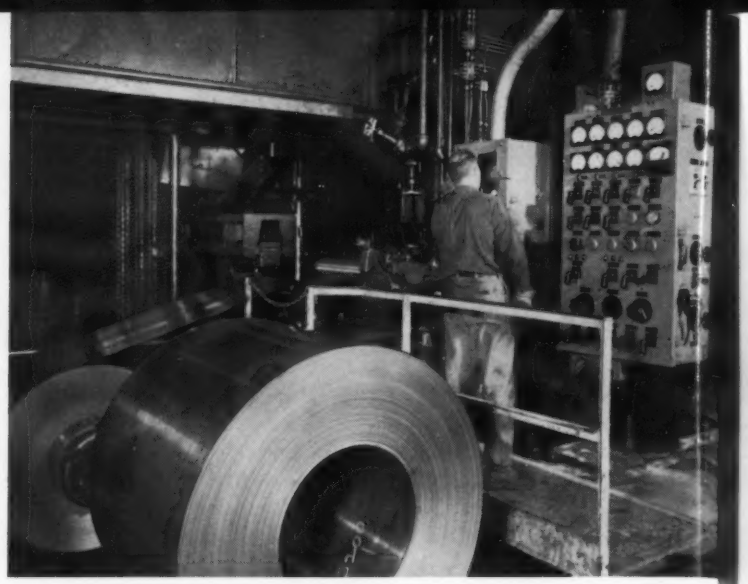


Figure 2 — Stand No. 5 is 12 ft-7 in. from winding reel.

of pickled hot strip are placed on the entry coil conveyor by overhead crane in the adjacent coil storage building, and moved into position in front of the mill. Each coil is then moved to the coil positioner by means of a coil kick-off and coil lowering device, and from the coil positioner the head end of the strip is fed through pinch rolls and guides and started into the No. 1 stand. The coil then is rolled forward from the coil positioner to the coil box, so that the next coil may be made ready in the coil positioner and started in the mill with minimum delay interval between coils. In the coil box, the coil is supported on cone mandrels to avoid damage from cradle rolls. The entry coil conveyor provides storage for from 8 to 12 coils, depending upon the strip width.

At the delivery end of the mill, coils may be removed directly from the stripper carriage by floor tractor, or may be moved by the stripper carriage to the delivery coil conveyor which affords storage for three coils, and the coils then may be removed from the conveyor either by floor tractor or overhead crane.

DRIVE ARRANGEMENT

Table II lists the main drive motor ratings, method of drive and the roll speeds available with different diameter rolls for each of the mill stands and the reel.

The working rolls of stands No. 1 and No. 2 are driven through pinion stands by direct coupled motors, the No. 1 stand motor being 2000-hp, 90/270-rpm single-armature, and the No. 2 stand motor 4000-hp, 150/375-rpm double-armature.

On each of stands No. 3, 4 and 5 the upper and lower working rolls are separately driven through off-setting step-up gears by the two units of a twin-motor drive. The No. 3 stand drive consists of two 2000-hp, 150/375-rpm single armature motors, and these motors are electrically duplicate of the No. 2 stand 4000-hp double armature motor. The No. 4 stand drive consists of two 2500-hp, 250/518-rpm single-armature motors. For the No. 3 and No. 4 twin drives, the off-setting step-up gear drives are duplicate, of 1 to 1.51 ratio and 67¼-in. horizontal center-to-center distance between the two input shafts. The two motors for each stand drive are installed at the same elevation with the upper roll drive motor close to and flexibly coupled to the right input shaft of the gear drive and the lower roll drive motor farther away and connected through a jackshaft along the side of the upper roll drive motor frame to the left input shaft of the gear drive.

The No. 5 stand twin-motor consists of two 3000-hp, 275/550-rpm double-armature motors, which drive through 1 to 2.0 ratio off-setting gears to the mill working rolls. The four 1500-hp units making up this 6000-hp, twin-motor are of special small diameter long core design to reduce the inertia and to enable installing the two double armature motors side-by-side on a common bedplate on 67¼-in. horizontal centers for flexible coupling to the two input shafts of the step-up gear drive.

The winding reel is driven by a direct-coupled 1500-hp 300/1120-rpm, triple-armature motor with magnetic brake.

Figure 3 is the speed diagram for the No. 3 tandem mill showing graphically the available operating speeds listed in Table II, also showing the required speeds for

TABLE II
48-in. Tandem Cold Reduction Mill Drive Ratings and Available Mill Speeds

Stand No.	Motor, hp	Motor, rpm	Drive	Roll, rpm	Roll, diameter			Roll, fpm		
					Max	Nominal	Min	Max	Nominal	Min
1	2000 single armature	90/270	Direct	90/270	21	21	18.25	495/1485	495/1485	431/1293
2	4000 double armature	150/375	Direct	150/375	21	21	18.25	825/2060	825/2060	718/1794
3	2—2000 twin	150/375	1:1.51	226/566	21.5	21	18.25	1272/3190	1242/3120	1081/2710
4	2—2500 twin	250/518	1:1.51	378/783	23	21	19	2280/4720	2080/4300	1880/3900
5	2—3000 double armature twin	275/550	1:2.0	550/1100	23	21	19	3315/6630	3025/6050	2740/5480
Reel	1500 triple armature	300/1120	Direct	300/1120	72	..	20.5	..	..	...

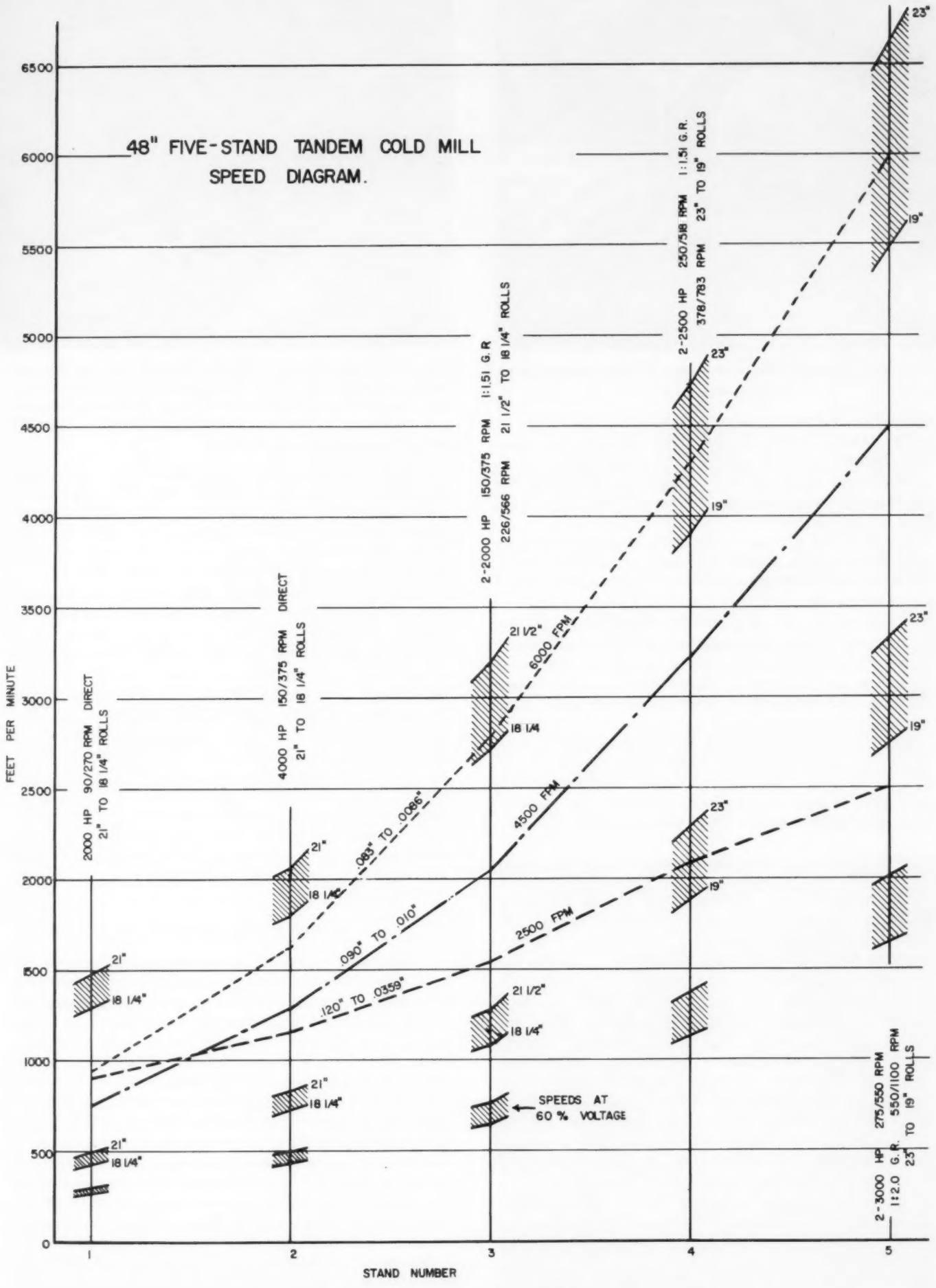


Figure 3 — Tandem mill speed diagram shows available speeds.

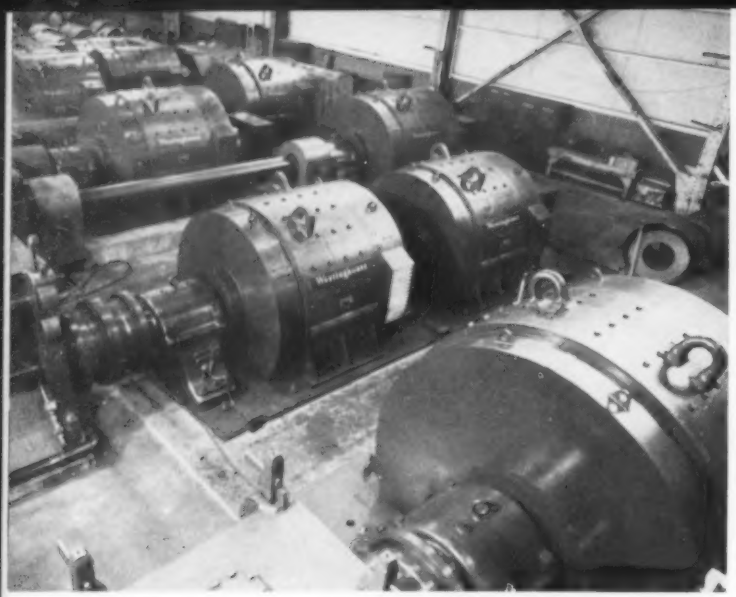


Figure 4 — General view of tandem mill main drive motors.

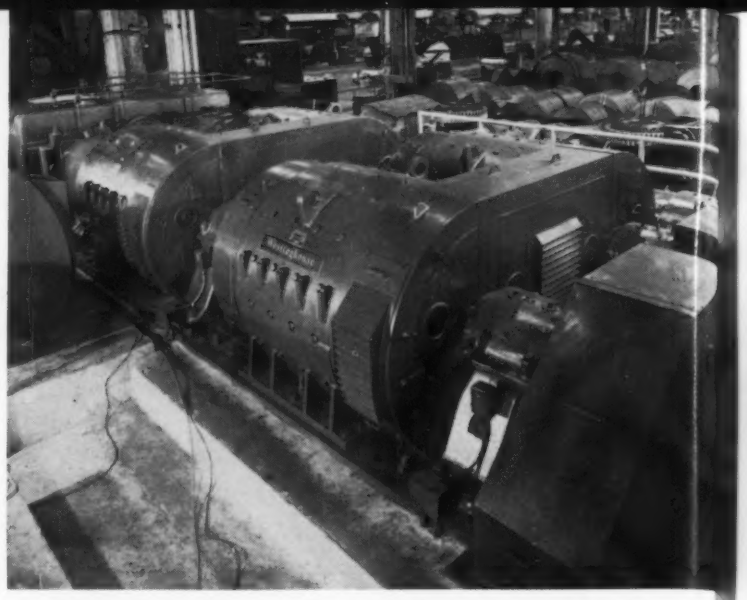


Figure 5 — Stand No. 5, 6000-hp 275/550-rpm double-armature twin-motor drive. The two 3000-hp double-armature motors are assembled on 67¼-in. horizontal centers and connected to the mill working rolls through 1 to 2.0 ratio off-setting step-up gears.

several typical rolling schedules covering the range of strip products. It is to be noted that the separate generator control system enables any stand drive (s) to operate down to 60 per cent voltage, thus extending the minimum operating speeds 40 per cent below the rated base motor speeds.

Figure 4 is a general view of the main drive motors with the stand No. 1, 2000-hp, single-armature motor in the foreground and the stand No. 5, 6000-hp twin-motor in the far background.

Figure 5 is a close-up view of the stand No. 5, 6000-hp twin-motor drive, showing the assembly of the two 3000-hp double armature upper and lower roll drive motors on the common bedplate and with common commutator end enclosure to facilitate access to the commutators and brushes.

Note that with this drive arrangement, the over-all lengths of the No. 2 stand double-armature motor, the No. 3, No. 4 and No. 5 twin-motors, and the winding reel triple armature motor, are all about the same so that they make a symmetrical over-all group.

MAIN POWER SUPPLY AND CONTROL

The mill and reel motors are operated in a separate generator adjustable voltage control system, and the eleven power supply generators are assembled on two main motor generator sets. Figure 6 is a single line schematic diagram showing the arrangement of the power supply generators and exciters. Motor-generator set No. 1 consists of one 1600-kw generator for the stand No. 1, 2000-hp motor, two 16-kw generators for the stand No. 2, 4000-hp motor, 12,000-hp, unity power factor 13,200-volt, 3 phase, 60-cycle 514-rpm synchronous motor, two 1600-kw generators for the stand No. 3, 4000-hp, twin-drive, and 1200-kw, generator for the 1500-hp reel motor. Motor generator set No. 2 consists of two 2000-kw generators for the stand No. 4, 5000-hp twin-drive, 12,000-hp synchronous motor, and three 16-kw generators for the stand No. 5, 6000-hp, twin-drive. The 1600-kw generators for stands No. 1, 2, 3 and 5 are duplicate, also the two 12,000-hp synchronous motors are duplicate.

Figure 7 is a view of the 35 ft wide by 225 ft long motor-generator and control substation showing the two main motor-generator sets and 13.2-kv, metalclad switchgear along the left wall, and the screwdown motor-generator sets, 2000-kva, 440-volt auxiliary power center, and exciter sets along the right wall. All of the main drive and auxiliary control equipment are installed on the mezzanine balcony at the right.

In the individual generator type control system, each stand drive is supplied from a separate generator (s), and the voltage of each stand generator is matched to a master reference bus so that the speeds of all of the stand drives are varied together by control of the reference bus voltage. The stand generator voltages are controlled by magnetic amplifier type voltage regulators, and the entire excitation for all of the stand generators is supplied from the 400-cycle bus and 150-kva alternator set. Direct excitation from the 400-cycle supply eliminates a separate generator exciter for each stand, gives faster response and inherently greater stability, and thus is ideally suited for maximum performance high-speed tandem mill regulators. This method of control has been applied with outstanding success to seven large tandem mills.

INSTALLATION IN EXISTING BUILDINGS

An unusual feature of the new tandem mill is that the mill, motor drives and motor-generator set and control substation, were all installed in existing buildings, resulting in a somewhat different arrangement and orientation of equipment than usual for an installation on a clear site. Figure 8 shows the plan of the mill, motor drives and substation, and Figure 9 shows a typical vertical section through stand No. 4. The mill stands are installed along the east side (11 ft-0 in. from building columns to center line of mill) of a 104 ft-4 in. wide building in the area previously occupied by the roll grinding shop, No. 2 tandem mill motor-generator set substation, white pickler, locker rooms, etc. It was necessary to install a new 60/25-ton, 101 ft-7½-in. span crane in this building.

The mill and reel motors, stand No. 1 and No. 2 pinion stands, and stands No. 3, No. 4 and No. 5 off-setting step-up gears, and the main oil cellar are located

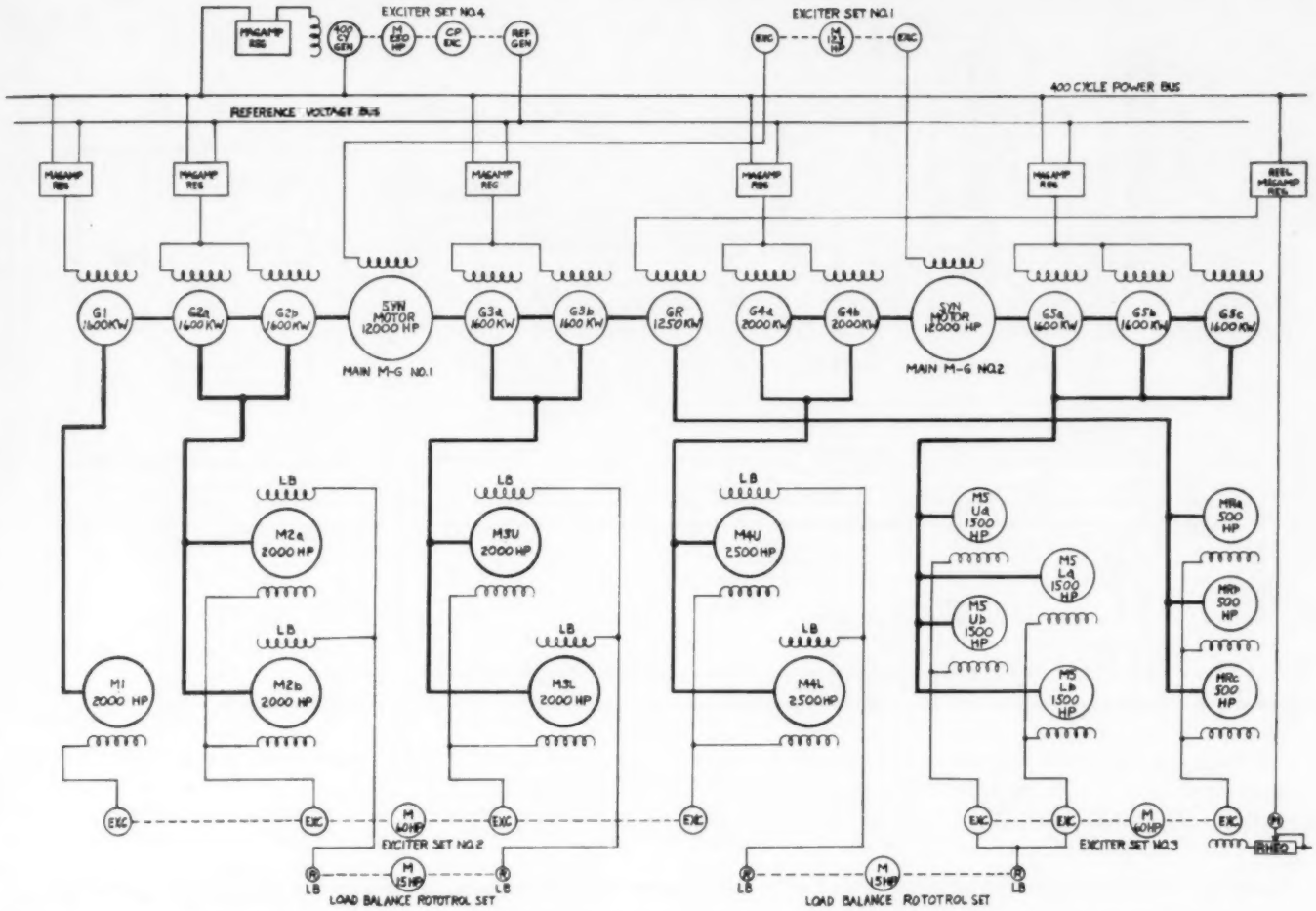


Figure 6 — Schematic diagram of connections for tandem mill main drive motors, supply generators and exciters.

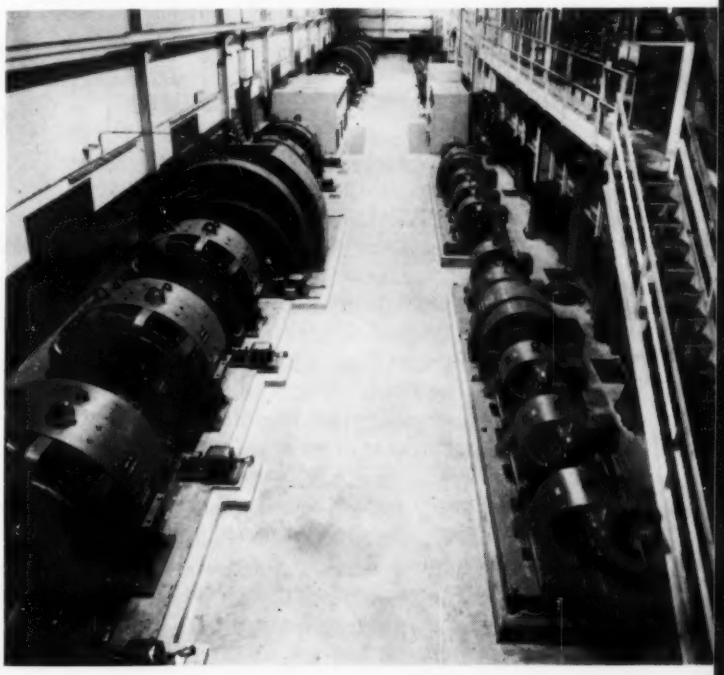
in the adjacent 54 ft-0 in. wide building, and this building also provides pickled hot coil storage with coils placed on the tandem mill entry coil conveyor by overhead crane. Existing cranes were retained in this building although some alteration of girders and crane rails was necessary.

The two main power supply motor-generator sets, screwdown motor-generator sets, exciter sets, 13.2-kv metalclad switchgear, and 2000-kva, 440-volt auxiliary power center, also the relocated 3500-kw motor-generator set and switchgear for the No. 2 tandem mill, are located in a 35 ft-0 in. wide by 225 ft-0 in. long building which previously had housed the hot dip tin house. However between the motor-generator set substation and the mill buildings there are a 16 ft-0 in. wide truck passageway and 19 ft-3 in. wide open railroad track. All of the main and auxiliary control equipment are installed on the balcony mezzanine above the truck passageway, the motor and generator line circuit breaker panels are located in the basement below the truck passageway, and the main bus connections to the motors are suspended from the basement ceiling under the truck passageway and the railroad track. Fitting the new mill and its drive equipment into the existing buildings required considerable ingenuity and imagination on the part of the layout engineers, and perhaps slightly increased the length of connections from the power supply generators to the control panels and mill drive motors, however in its finished form the mill arrangement is logical and compact, and convenient to operate and maintain.

VENTILATION SYSTEM

Ventilation of the mill and reel drive motors, main power supply motor-generator sets, and substation auxiliary equipment, is by means of an updraft non-

Figure 7 — Motor-generator set and control substation for tandem mill.



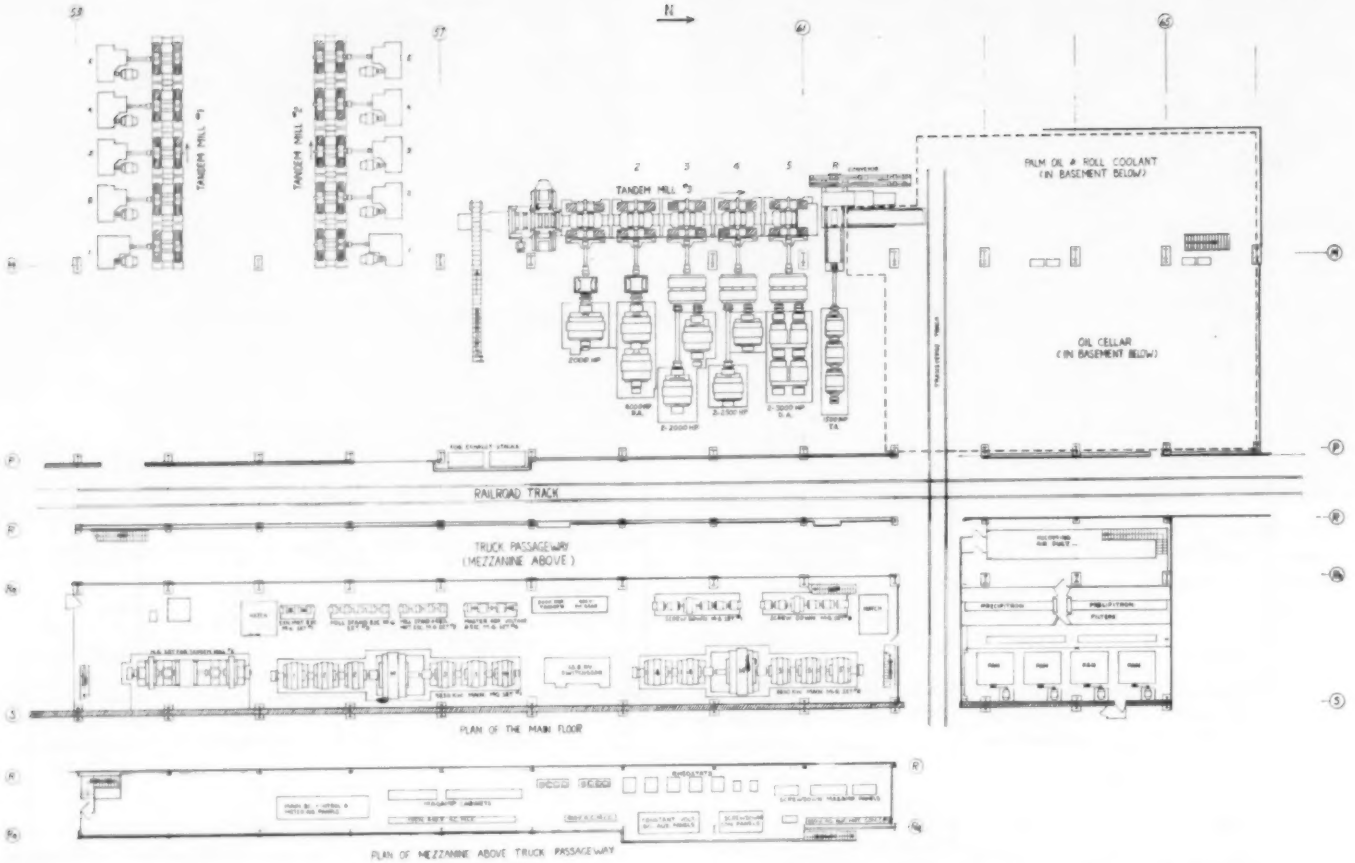

TANDEM MILL #1
TANDEM MILL #2
TANDEM MILL #3
PALM OIL & ROLL COOLANT (IN BASEMENT BELOW)
OIL CELLAR (IN BASEMENT BELOW)
RAILROAD TRACK
TRUCK PASSAGEWAY (MEZZANINE ABOVE)
PLAN OF THE MAIN FLOOR
PLAN OF MEZZANINE ABOVE TRUCK PASSAGEWAY

Figure 8 — Plan arrangement of tandem cold strip mill, motor drives and motor-generator set and control substation.

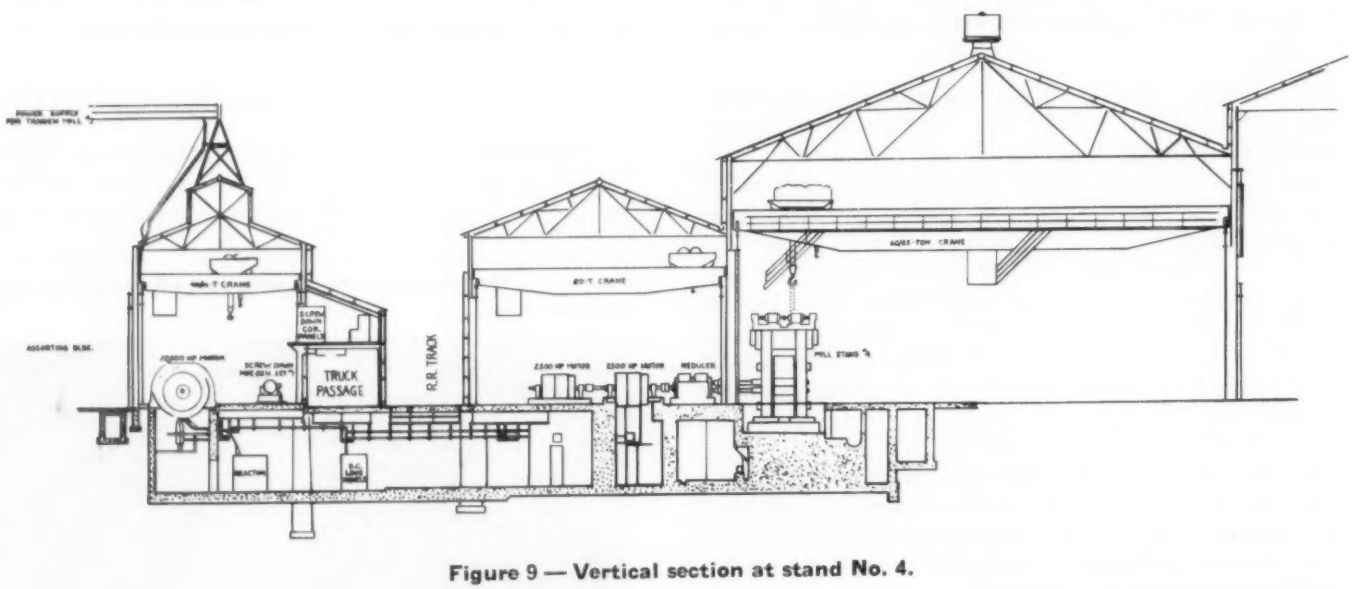


Figure 9 — Vertical section at stand No. 4.

recirculating ventilation system, consisting of electrostatic air cleaners of 476,000-cfm total rated capacity and four 110,000-cfm fans. The only conveniently available space for the ventilating equipment was about two and one-third bays in the building in line with the motor-generator and control substation. Two 14-ft high precipitator assemblies are arranged one above the other at the basement and main floor elevations. The four fans deliver air through a common duct to the substation basement, and adjustable dampers are provided in the air inlet opening to each of the mill and reel motors, power supply generators and synchronous motors, to proportion the air.

AUTOMATIC GAGE CONTROL

An important feature of the tandem mill control and regulating system is the automatic gage control as applied to the operation of the No. 1 and No. 5 stands. The over-all gage control system consists of one gage installed between stands No. 1 and No. 2 and controlling the stand No. 1 screwdown to minimize variations in thickness of strip going to the rest of the mill; and a second gage installed between stand No. 5 and the reel and controlling the strip tension(s) for vernier adjustment to regulate the thickness of the finished strip.

Figure 10 is a block diagram of the complete over-all

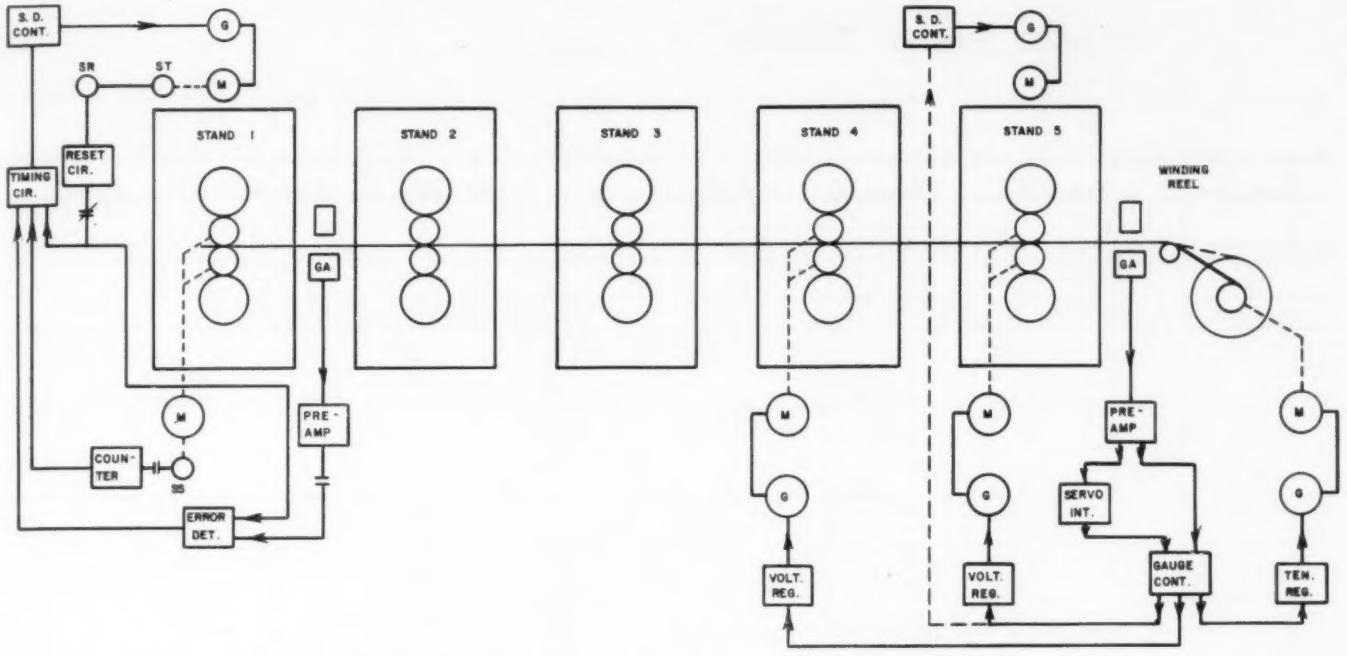


Figure 10 — Block diagram of tandem mill automatic gage control.

gage control system. The deviation from set strip thickness or error signal, taken from the radiation type gage between stands No. 1 and No. 2, is amplified in a magnetic preamplifier and then fed to the error detector. When the error is greater than a predetermined value, a signal will be transmitted from the error detector to the timing circuit. The timing circuit is initiated by the sampling switch, driven from the stand No. 1 motor, and the counter, which together act to measure the length of strip delivered from stand No. 1. Measuring the strip length is necessary to insure that once the gage control has made a corrective action it will not operate a second time until the thickness gage has seen the effect of the first corrective action. The length of time that the timing circuit will jog the screwdown is a function of the gage error at the instant the timing circuit initiates the screwdown jog, so that the correction which is made is proportional to the error, thus minimizing the number of screwdown movements, reducing over-shoot, and bringing the strip on gage more quickly. A synchro-tie reset servo is provided to automatically reset the screwdown to the preselected position when the tail end of a strip leaves the mill, so that the rolls will be in their original position when the next coil is started through the mill.

Variable voltage screwdown control provides quicker response, smoother operation and reduced maintenance, for the relatively frequent operation of the gage control on stand No. 1, also is applied on the remaining stands to provide smooth operation, and stability at low speed for making small adjustments during rolling and at high speed for large movements when changing rolls and setting up the mill. The two screws on each mill stand are driven by two 75-hp, 515-rpm, 230-volt frame 612 shunt-wound mill type motors, and each motor is supplied from a 75-kw, 250-volt generator which is capable of developing 500 volts maximum to operate the motors up to 1100 rpm for roll changing.

The gage control by stand No. 1 screwdown provides the coarse control of strip thickness, so that the gage control at stand No. 5 needs to provide only a vernier or fine control of the thickness of the delivered strip. The deviation from the set strip thickness or error signal taken from the radiation type gage between stand No. 5 and the reel, is amplified in a magnetic preamplifier. The magnified error signal is fed directly to the proportional type gage control regulator to provide fast response to bring the strip on-gage quickly when threading and accelerating the mill, also is fed through a servo integrator and then to the gage control regulator to provide maximum accuracy under steady state conditions. The gage control regulator then feeds into the stands No. 5 and No. 4 generator voltage regulators and into the winding reel tension regulator to control the strip tensions between stands No. 3–4, stands No. 4–5, and stand No. 5-reel, and thereby control the thickness of the delivered strip. Provision also is made so that at preselected limits of tension adjustment, the stand No. 5 screwdown setting is changed to bring the tension control back into range.

Figure 11 shows sections of strip thickness charts from the gage at stand No. 1 and the gage at stand No. 5, taken during the normal rolling of seven coils, with the mill operating at about 3500 fpm and finishing 0.0119-in. thick strip. It is noted that the average thickness from stand No. 1, shown on the upper chart, holds very closely to the gage setting of 0.060-in., and that the total variation, most of which is random "noise" in the gage, is only about ± 0.0006 in. Also that the average thickness from stand No. 5, shown on the lower chart, holds very closely to the gage setting of 0.0119 in., and that the total variation is only about ± 0.00015 in.

Only a few large welded coils have been rolled to date on the new tandem mill, as the revamping of the pickle line has been completed only recently. Figure 12 shows sections of strip thickness charts at stand No. 1 and stand No. 5, with the mill operating at about 3600 fpm and delivering 0.010-in. thick strip, with welded joints going through the mill at normal rolling speed. On the

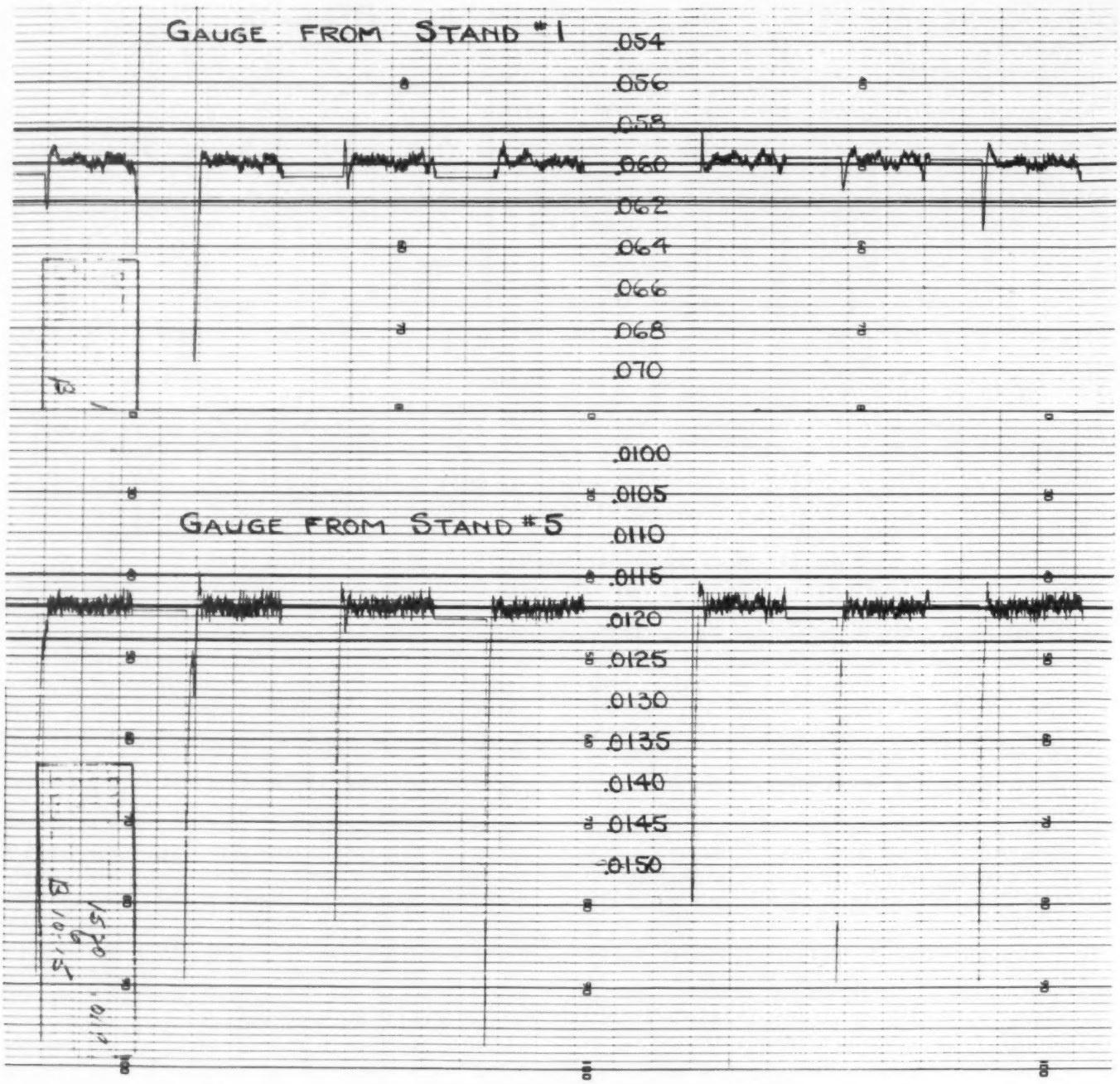


Figure 11 — Strip thickness from stand No. 1 and stand No. 5 with automatic gage control.

first coil, with apparently rather large difference in thickness between the tail end of the first entering hot strip and head end of the second entering hot strip, there was a fairly large transient disturbance at both the stand No. 1 and stand No. 5 gages, however the gage control quickly brought the strip back on-gage. On the second coil the transient disturbance was much smaller because of the lesser difference in gage at the weld of the hot strip entering the mill.

SUMMARY

The paper has described the significant features of a modern high-speed tandem cold reduction tinplate mill, and has indicated the problems involved in fitting a major mill into existing building facilities. Also the paper has emphasized the necessity for automatic gage control on a high-speed mill and has shown some of the results achieved with the gage control on this mill.

Discussion

PRESENTED BY

R. G. BEADLE, Metal Rolling and Processing Engineering, Industrial Engineering Section, General Electric Co., Schenectady, N. Y.

A. F. KENYON, Advisory Engineer, Industrial Engineering Dept., Westinghouse Electric Corp., East Pittsburgh, Pa.

H. W. DORSET, Assistant Superintendent, Electrical Dept., Bethlehem Steel Co., Sparrows Point, Md.

NELSON W. HOCKING, JR., Chief Plant Engineer, Wheeling Steel Co., Yorkville, Ohio.

R. G. Beadle: I have a few questions to ask to help clarify for me some of the thinking involved in the design of the electrical equipment. First, you have indicated that one advantage of magnetic amplifier excita-

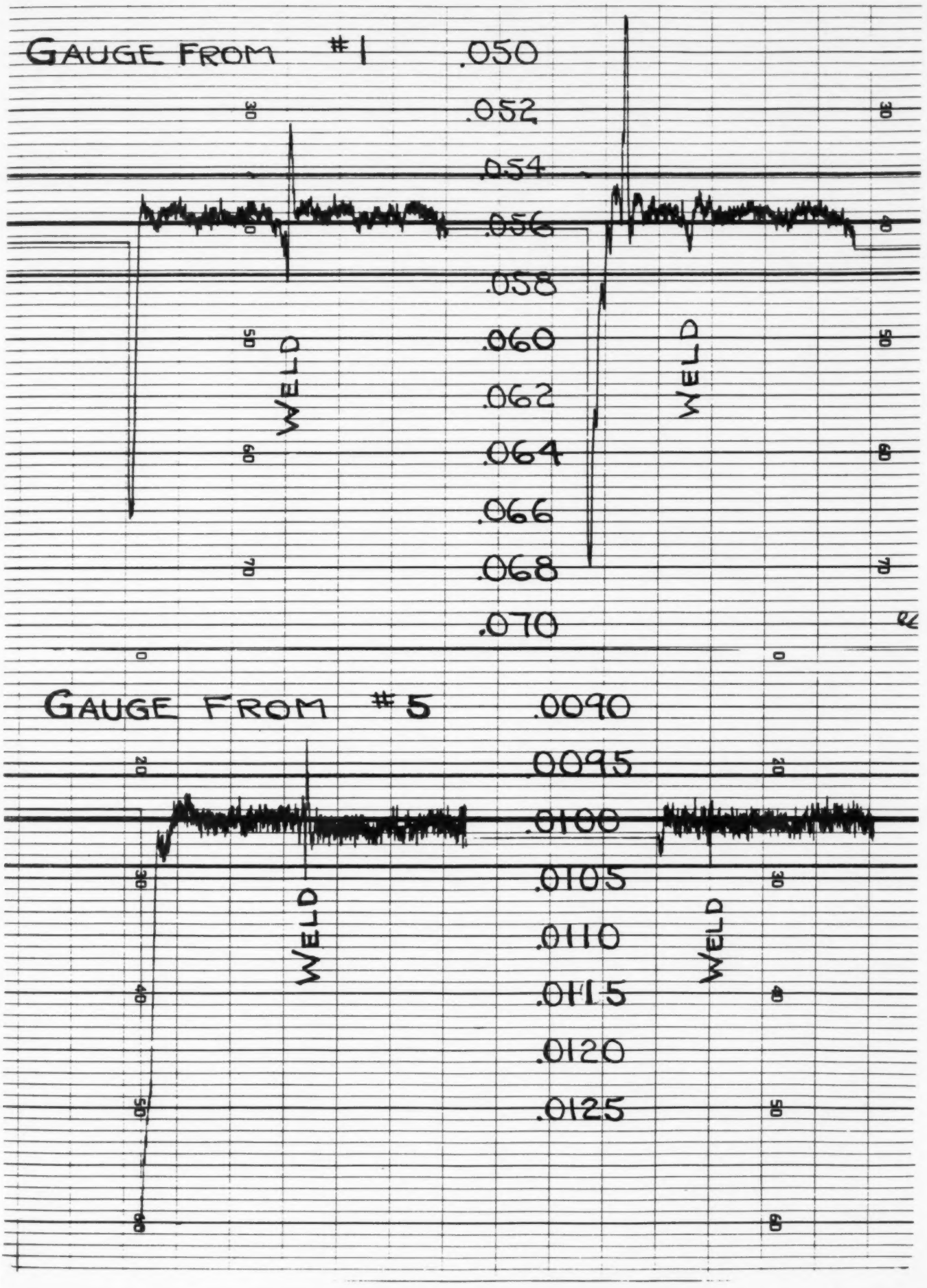


Figure 12 — Strip thickness charts with automatic gage control rolling welded coils shows transient disturbance at welds.

tion of the stand generators is the elimination of six generator exciters. Will you give your opinion on using magnetic amplifiers, either 60 cycle or 400 cycle, for motor field excitation? Counting both exciters and load balance rotating regulators, eleven rotating machines could be replaced.

Have you had any significant experience with the load balance between top and bottom motors of the three twin drives? It has been my experience on high-speed twin drives, that load balance tends to increase the tendency to scratch the strip at high speeds. For example, if slipping begins to occur on one roll, the load on that roll will decrease. Load balance then weakens the motor field to pickup load, but this merely increases the slipping. From actual experience in improving this condition, we have desensitized or removed load balance from nearly all twin drive stands. Can you comment on this?

The last question concerns the gage control system employed on this mill. Here you have used a coarse control on stand No. 1 screwdowns and a vernier control which modifies tension between the later stands. It is this general form of coarse-vernier control which engineers of my company favor.

At the AISE meeting last year, two of your associates, Messrs. Cook and Wallace, co-authored a paper on another form of gage control which used tension between all stands but did not use a coarse control on stand No. 1 screwdown. Now that you have had experience on both forms of control, can you make any comparison of accuracy or response assuming the same gage variations entering stand No. 1?

A. F. Kenyon: On the Wheeling mill, the motors were excited from conventional rotating exciters, although it was recognized that excitation and control from magnetic amplifiers, the same as for the generators, would have advantages. On two new tandem tinplate mills, now in manufacture, the stand and reel drive motors, as well as the power supply generators, will be directly excited through 420-cycle magnetic amplifiers, also load balance will be effected through similar static regulators. This system has manifold advantages of eliminating all rotating exciters and regulators, assures fast response to rheostat movements, enables complete factory assembly, wiring, and testing of cubicle type control, reduces floor space requirement, and reduces interconnections between separately installed exciters, rheostats, regulators, meter and control panels.

Strip scratching has not been a problem insofar as load balance on the upper and lower roll drives is concerned. In the early operation of the mill, most rolling was on relatively short single coils, and operating speed was on the order of 3500 to 4500 fpm. Trial coils have been rolled at 6000 fpm without experiencing any serious difficulty. Both the new Wheeling mill with automatic gage control by combination of screwdown and tension adjustment, and the mill described in a paper presented at the 1957 AISE meeting with automatic gage control by tension adjustment throughout the mill, are obtaining successful operation and acceptable gage accuracy. For general application on most tandem tinplate mills, we prefer the combination system primarily utilizing screwdown adjustment at No. 1 stand for coarse control and tension adjustment between later stands, for fine control, although variations of this basic system have been devised to meet particular requirements. Present more refined systems also incorporate tension limiting controls to automatically jog screwdowns or stand speeds to keep interstand tensions between maximum and minimum values.

H. W. Dorset: The engineering must have presented many problems due to installation in existing buildings, but they seemed to have solved these problems very well.

We have, at Sparrows Point, a five-stand tandem mill completed early in 1957 by the Bethlehem Steel Co. which is a very close duplicate of this mill.

The motor speeds are very close, the gear ratios are identical, and the speed cone very similar. We have slightly smaller motors on the first and second and fifth stands and correspondingly smaller generators. The reel motor has a higher top speed than this mill mainly because the reel mandrel is only 16 in. in diameter, however, the two main motors on the motor-generator sets are of identical horsepower.

The ventilating system of our mill is pretty much a duplicate in that the capacity is approximately the same and the method of nonrecirculation of air is the same, however, we have utilized six blowers instead of four. There is one each for the two main motor-generator sets, two for the mill basement of approximately the same capacity and two of approximately the same capacity feeding the main mill motors.

The intake air for this ventilating system is drawn through two stacks approximately 125 ft high and filtered through a movable filter media. We have found on tests the air in this mill to be exceptionally clean.

The mill at Sparrows Point is somewhat more compact, as we were fortunate in having a completely new building. The main mill motors and motor-generator sets are in the same building as the mill itself. The two main motor-generator sets are in line with the main mill motors; one of them at the delivery end of the mill and one at the entry end. Some space in front of the mill for roll change is sacrificed by this method. All of the control, screwdown motor-generator sets, circuit breakers, etc., are installed in a basement directly behind and underneath the main mill motors. This basement extends under an adjoining building.

The automatic gage control on the Sparrows Point mill is very similar in its operation to the mill described, however, we do not control tension between the third and fourth stand nor between the fifth stand and the reel. Although available, our operating personnel do not use the reset for preselected position when the tail-end of the strip leaves the mill.

I believe it is generally agreed by everyone that automatic gage control is necessary on mills of this high speed if a high percentage of "on gage" product is desired.

I do not have any particular questions to ask, except I would like to know somewhat out of curiosity just how much strip they roll at Wheeling in the lighter gages at a finishing speed of 6000 fpm.

Nelson W. Hocking, Jr.: We appreciate Mr. Dorset's comments. We visited Sparrows Point to inspect their mill prior to engineering our mill.

We do not consider rolling strip at 6000 fpm as a normal rate. For a short trial period the mill was run at about 5800 fpm. Our normal mill speed for the lighter gages is 4000 to 5000 fpm. ▲

Increased Open Hearth Production With The Use of Oxygen

by T. A. THOMPSON
Assistant Superintendent Open Hearth
Weirton Steel Co.,
Div. of National Steel Corp.,
Weirton, W. Va.

Thorough attention to detail, coordinated planning, adequate material handling, oxygen, and basic brick promise many new steel production records.

A REVIEW of Weirton's experiences in using oxygen gas may renew precautions for pitfalls which can be encountered as well as review practices which may increase production with oxygen.

One day, in December, 1958, a record heat was made on No. 1 furnace. After some initial preparations in the way of getting a supply of blown metal ready, the furnace was made up in half an hour and scrap charging was started at 1 P.M. in the amount of 105,000 lb of bloom butts and 70,000 lb of strip mill scrap. This was all charged by 1:30 P.M. At 2:00 P.M. a blown metal charge was started and in 2 hr 40 min a total of 1,128,000 lb was in. A 10,000 lb drink was put in at 5:45 P.M. Sixty-three thousand pounds of raw lime was charged initially with the addition of twenty-four thousand pounds of burnt lime charged in at 2:40, 3:20 and 4:00 P.M. Oxygen was put on the burners at 1:30 P.M. at the rate of 30,000 cfhr and taken off at 6:00 P.M. Oxygen was put on the lances at 2:45 P.M. at the rate of 35,000 cfhr per lance, later raised to 40,000 cfhr at 5 P.M. When the carbon had dropped to approximately 40 points, lances were held at six to eight in. above the bath as much of the time as possible.

The heat was tapped at 6:05 P.M., in the amount of 585.9 tons which resulted in a heat time of 5 hr 5 min, charge-to-tap and 5 hr 35 min tap-to-tap, and a tonnage rate of 115.3 tons per hr charge-to-tap or 104.9 tons per hour tap-to-tap. The fuel rate was 6.5 gal of oil per ton, and the oxygen rate was 898 cu ft of oxygen per ton used in the ratio of 23 per cent on the burners and 77 per cent on lances.

The oxygen roof lances were of the standard type, of which there were three. Each lance has 6½-in. holes equally spaced around the perimeter of the nose, the axis of the holes being at an angle of 20 degrees to the axis of the lance.

This heat was made, not as a regular production practice, but just "one for the book." This heat revealed several points which are necessary for maximum production. One is the importance of furnace make-up time, and material handling rates. Another point is that these fast heats require individual supervision to maintain the schedule needed. For instance, during our record heat we had our steel works manager, the superintendent of the shop, the bessemer superintendent, two melters, the assistant superintendent of open hearth and the combustion engineer. The third point of importance is the proper use of oxygen and the lance.

This record heat is just the beginning of a major industry-wide production advance, with 150 tons per hr as a not too distant achievement. Of course the amazing progress our friends using the top blown oxygen converter process are making, plus the reduced cost and tonnage quantities of oxygen, has greatly influenced our thinking toward the present trends in open hearth operations.

The open hearth process is one essentially of oxidation at high temperature. Historically the source of oxygen for the process has been iron oxide in the form of ore containing 25 to 30 per cent oxygen by weight. The use of ore has several disadvantages: it has to be charged in, it contains silica which in turn requires more lime, and finally the chemical reactions between the ore and bath are strongly endothermic or heat absorbing. For example, to react one lb of ore requires about 1200 to 1500 btu, or one lb of oxygen introduced via the ore, decreases the bath temperature of one ton of metal by 10 F. Much the same reasoning applies to the other sources of oxygen such as sinter, limestone and roll scale. It was discovered in the early 1800's that the reaction of air with molten iron to burn out carbon not only generated enough heat to carry on the reaction but also provided some extra heat. During the past 10 to 15 years, the use of oxygen gas has become another tool in the open hearth for obtaining high rates of decarbonization and the production of higher temperature in the bath. Since oxygen gas can be introduced into the bath through roof lances at the touch of a switch, does not require lime or slag changes, does not result in a temperature loss to the bath and has a favorable carbon drop cost compared with the use of ore, it is little wonder that its use is

becoming more important. To obtain rapid decarbonization rates, it is not only necessary to supply oxygen for the carbon reaction, but also to maintain the steel and slag saturated with oxygen. One must provide an oxygen driving force with respect to this reaction which is similar in thought to the heat head necessary to drive heat into a bath at 3000 F.

There are seven furnaces at Weirton equipped with oxygen roof lances and oxygen for combustion. This discussion will cover experiences with four of them. No. 1 furnace is rated at 550 tons, with a bath area of 1221 sq ft and a depth of 45 in. The maximum firing rate is 126,000,000 Btu per hr, and the oxygen flow through the three lances is 105,000 cfhr. No. 5 furnace is rated 280 tons, with a bath area of 818 sq ft and a depth of 40 in. The maximum firing rate is 90,000,000 Btu per hour, and the oxygen flow through the two lances is 60,000 cfhr. No. 10 furnace is rated at 450 tons, with a bath area of 888 sq ft and a depth of 48 in. The maximum firing rate is 117,000,000 Btu per hr, and the oxygen flow through the two lances is 70,000 cfhr. No. 14 furnace is rated at 600 tons, with a bath area of 1296 sq ft and a depth of 43 in. The maximum firing rate is 144,000,000 Btu per hr and the oxygen flow through the three lances is 105,000 cfhr. No.1, 10 and 14 furnaces are all basic, while No. 5 furnace is of silica construction with basic end walls. No. 1 and 14 furnaces are equipped with complete combustion controls and automatic reversals, while No. 5 and 10 are hand-operated furnaces.

The original experimental lance work was done on No. 5 furnace. The lance control was arranged so that the lance on the outgoing end was in service and the lances reversed with the furnace. The burner oxygen also reversed with the furnace. The next step was to use both lances together and the final change has been to make the lance oxygen and burner oxygen independent of one another so that each can be used when desired. The original lance had a single 1-in. oxygen pipe extending through the lance head. It did not take too many heats to determine the shortcomings of this construction; the amount of slag splashing against the silica roof minimized the oxygen flow to a point where operation was affected. The next change was to the use of six equivalent area holes spaced around the periphery of the lance head; the axis of the holes being 20 degrees from vertical. This is a more or less standard now in our shop and probably in the industry. The single hole lance operated very well but some more work should be done toward eliminating the splash.

Four types of heats were made on No. 5 furnace, with and without oxygen, for comparison purposes: scrap heats, sinter or ore heats, blown metal with sinter or ore and straight blown metal heats. Comparing these heats with one another resulted in the following conclusions: On the scrap heats, the tons per hr charge-to-tap increased 24.6 per cent; the gal per ton decreased 52 per cent, and the oxygen used was 929 cu ft per ton. On the sinter and ore heats we did not do too well, gaining about 3 per cent on tons per hr charge-to-tap, while the fuel rate decreased 26 per cent. On the blown metal and ore heats, the tons per hr charge-to-tap increased 14.9 per cent; and the fuel rate decreased about 7 per cent. The oxygen rate was 600 cu ft per ton. On the blown metal heats the tons per hr, charge-to-tap, increased 29.5 per cent and the fuel rate decreased 55 per cent. We determined on this test with our fuel, oxygen and lance cost that a savings in fuel of 7.8 gal per ton, or 26 per cent, would pay the cost of the oxygen and lances. Roof life was about the same.

Comparing the performance of No. 1, 10 and 14 furnaces is rather inconclusive because the furnaces were converted into a basic furnace before oxygen was tried and we have but 22 heats with no oxygen to compare. But comparing the silica furnace with the basic furnace with oxygen, results in some interesting data. On No. 10 furnace for instance, the tons per hr went from 32.8 up to 57.2, the fuel rate went from 19.5 gal per ton to 24.1. Oxygen was used at the rate of 795 cu ft per ton. Roof life went from an average of 110 to 237 on our first basic roof. It is only fair to mention that 12 per cent more blown metal was charged on the oxygen practice.

On No. 14 furnace the performance has not been quite as spectacular. As a silica furnace the tons per hr charge-to-tap was 42.5 tons, while on the oxygen practice, the tons per hr increased to 54. The fuel rate went from 17.2 gal per ton down to 16.8. Roof life on this furnace increased from an average of 170 to 314 heats on the first basic roof, with first patch on basic roof at 297 heats. This data reflects the fine performance of this furnace on silica, as compared with basic. The oxygen rate on this furnace was 1191 cu ft per ton.

No. 1 furnace made a total of 344 heats on the first basic roof of which 310 heats were made with oxygen. This run compares with average runs of 140 heats, with a high of 170 heats, on the silica roofs. The tons per hr charge-to-tap on the silica roofs was in the order of 40 tons per hr at a fuel rate of 14 gal per ton. As a basic furnace with oxygen, this furnace in 310 heats averaged 47.1 tons per hr at a fuel rate of 18.1 gal.

While the fuel rate on the rebuilt basic furnaces is higher on oxygen practice, we have come to the conclusion that part of the increase is due to the fact that not only can a basic furnace be fired harder, but that it requires a higher firing rate just to maintain its heat head. We ran some 22 heats on two of these furnaces without oxygen and in both cases the fuel rate increased at least 20 per cent just to maintain the tonnage rate.

We have come to some conclusions as to the use of oxygen regarding oxygen practice, furnace practice and furnace maintenance. As to the use of oxygen in the burners for combustion, we are using from 30 to 40,000 cfhr, depending on furnace size and we feel this oxygen flame melts scrap faster for the reasons of higher flame temperature, and more Btu's per sq ft of hearth. The oxygen rate through the lance is now 30,000 cfhr per lance. We are developing a program for lance use such that after two ladles of metal are charged, the lances are to be lowered to about 12 in. above the bath. This elevation is desirable so that further addition of metal will not submerge the lance. In addition, the carbon level is so high that the efficiency of the oxygen does not fall off too rapidly.

A third reason for this elevation is that once the lance is turned on, there is so much fume developed that one cannot see what he is doing. After all the metal is in, the lances are dropped down to 6 to 8 in. above the bath. When the carbon drops to a range of 40 points, another 5000 cfhr oxygen is put on the lance. Lance

life has not been too good, averaging 50 to 60 heats per lance. Through some quirk of nature, one lance lasted for 120 heats. Our problem is one of supplying enough water; the lances, being operated on our mill, use water at a pressure of 15 to 20 psi. We have tried the lances of three different companies. Our own home-made lances look to be as good as anything we have bought. The life of the oxygen lances is improved by operating the lances at a sufficient pressure, such that the exiting gas will direct the splash of a boil away from the lance. In our particular operation, we try to keep the pressure over 80 psi.

The changes in furnace practice might be summed up as follows: We have almost entirely eliminated the charging of bottom scrap. This has a further benefit inasmuch as the lime can be charged more evenly, and this in turn shows up later on in the heat with a more even lime boil. Because the use of the oxygen lance has some effect on the slag which requires the use of feed lime, less raw limestone is used on the charge, and burnt lime is added as necessary. Because the oxygen furnace will go if given a chance, a decided step-up in charging requirements is needed. Heavier scrap, better filling of scrap buggies and better management in the transportation end will all be necessary. The addition of burnt lime ore and hot metal must be speeded up. If charging is not speeded up, the furnace will "get ahead of itself," and not only will the delays be compounded but the oxygen used will be wasted. For the over-all charge, a higher percentage of metal is used, so that the heats will melt out better.

With a basic furnace and oxygen lances, the roof is no longer the familiar weak point. Instead, many other areas which have never been a problem before will suddenly become important and many situations will arise which never presented themselves. First of all, a basic furnace is a leaky furnace, and with oxygen it becomes a dirty furnace. These develop into a situation, when the basic brick spall and the bath fume begins to fill up the slag pockets, close over the uptakes, plug the checkers, fill up the flues and get into the boiler.

We have had to open the uptakes and knock out the buildup with a paddle arrangement on the charging machine. We have taken the slag out of the slag pockets. We have gone to a high pressure water spray system to clean the checkers. We almost doubled the soot blowers in the flues. Boiler outage is increased, much to the detriment of the furnace. To alleviate this, we are using a chemical cleaner in the uptakes to keep the dirt loose.

In the second place, a basic furnace with oxygen is a hotter furnace, and this extra heat, along with the slag and metal erosion, will soon show up weak spots before unnoticed. We have had to clean the cooling water better, going over screening systems more often, and put more water on such areas as door jambs, backwall, skew, etc. To cool the vertical chill, we are installing blowers on our basic furnaces and are blowing the dust off the roofs. We have started a gunning program for spraying of backwalls, roofs, ports, uptakes and any other accessible areas. The furnaces must be made up more often with raw dolomite, over the scrap and over the heat, since the slag is carried at a higher temperature and the banks must be protected and maintained efficiently.

Discussion

PRESENTED BY

ROBERT CONKLIN, General Foreman, Open Hearth, Wheeling Steel Corp., Steubenville, Ohio

W. E. WILLIAMS, General Foreman, Fuels & Instruments, Fairless Works, United States Steel Corp., Fairless Hills, Pa.

T. A. THOMPSON, Assistant Superintendent Open Hearth, Weirton Steel Co., Div. of National Steel Corp., Weirton, W. Va.

J. SULLIVAN, Assistant to Superintendent—Melt Shop, Republic Steel Corp., Chicago, Ill.

A. T. PETERS, Supervising Metallurgist, Open Hearth & Blooming Mill, Metallurgical Dept., Indiana Harbor Works, Inland Steel Co., East Chicago, Ind.

S. LAWRENCE, Engineering Supervisor, The Steel Co. of Canada, Ltd., Hamilton, Ontario, Canada

Robert Conklin: Our most informative run using oxygen was with our No. 7 furnace. This is a 215-ton furnace with a bath depth of 38 in. and a hearth area of 709 sq ft. The furnace had a 9-in. basic roof with 12-in. ribs extending three ft beyond the knuckles. The balance of the slope was 15-in. silica brick. No other changes were made to the furnace, either as to the construction or refractory material used.

Two standard lances were installed in the roof on the centerline at No. 2 and 4 doors. They were used for 201 of the 225-heat campaign. The lance heads had six equally spaced $\frac{3}{8}$-in. holes. The holes were varied between 20 and 30 degree inclination to the vertical for evaluation purposes. Lance life varied from less than one to a maximum of 42 heats.

The lances were lowered after the first of two ladles of metal and were retracted when the lime boil had become vigorous. Lance oxygen was 95 per cent purity and rate of flow was 25,000 cfhr per lance. Combustion oxygen was used before and after lancing but not at the same time.

The first 80 heats were made using a controlled ore charge of 40,000 lb. However, for the balance of the campaign, due to restricted availability of hot metal, it was necessary to vary the ore charge so that the amount of metal charged in No. 7 furnace was in line with the rest of the shop.

The average stone charge was 20,000 lb for the shop, but was dropped to 15,000 lb for No. 7.

The best heat time was 5 hr 35 min., tap-to-tap, which was a rate of 36.61 tons per hr. Other comparative figures were as follows:

	No. 7	Shop (Less No. 7)
Tons per heat	211.1	216.3
Charge-to-tap Time (hr)	8.04	10.27
Tap-to-tap time (hr)	8.79	11.01
Tons per hr (tap-to-tap)	24.02	19.65
Million Btu per ton	2.098	2.873
Lance oxygen (cu ft per ton)	741	None
Combustion oxygen (cu ft per ton)	253	541
Total oxygen (cu ft per ton)	994	541

I might add that at the end of the campaign we had an umbrella; that is, a roof with everything else burned out. What time we saved in not patching the roof we lost in patching the rest of the furnace. Also, the downstairs

was almost completely plugged.

W. E. Williams: The instrumentation and combustion control equipment are available to do the oxygen beneficiated job, but more thought must be given to the often dirty and therefore forgotten items. These include the checkers, flues, boilers and induced draft fans.

The precipitator manufacturers and plant personnel have arisen to the task of providing the necessary cleaning facilities to meet the dust loading standards; however, much more thought must be given to performing the job more efficiently in less space for considerably less money.

I agree that with the advent of basic furnaces and oxygen lances, delays will be compounded as the operator gains knowledge in the more efficient use of lance furnaces. More thought must also be given to transportation and handling of the raw materials. Another potential delay to keep in mind with the inclination toward large furnaces is the handling of molten steel. This is particularly true in plants that are expanding their present facilities.

You stated that of the 110,000 cfhr of oxygen used, 23 per cent was used as flame enrichment. Since we have been unable to justify the use of oxygen for flame enrichment, I would like to ask how much do you attribute to the use of flame enrichment? Do you not think the same or better results may have been gained if all the oxygen had been used on the lances?

I assume that the burners in your furnaces are directed at the center of the bath. If this is true, have you given any thought to directing the burners toward the bottom of the lance nearest the burner?

T. A. Thompson: I might say that we certainly agree that the flame enrichment is not as beneficial as the lance, but when we have oxygen available, we use it as we have it through the burners and only at that time. If the furnaces are coming so we can use it through the lances, we use none through the burners.

The other question you asked was about the angle of the burner. Our burners are located on the centerline of the furnace ends and are movable in the vertical plane only. The lances are located on the centerline of the furnace itself and the two centerlines are not in line. We feel it would be too much effort and uncertainty to make the burners movable in the horizontal plane and certainly quite an engineering feat to direct the lances themselves to make this directing possible.

J. Sullivan: On the heat you made for the book, could you tell me the approximate chemistry of the blown metal? Did you consider 63,000 lb an excess of stone? Was it all cleaned up when you finished the heat? Aside from that heat you mentioned water sprays to clean checkers. I wondered if you noticed very much detriment to any basic brick that might be in the area. When you put oxygen through the lances, does it help limit the checker temperature? Does it keep it lower? Do your lances rise automatically if your coolant water-pressure is low?

T. A. Thompson: First, referring to the chemistry of the blown metal. We blew that metal down to 1.25 per cent carbon. We did not consider the amount of lime charged as excessive and we followed the heat with burnt lime to balance our ratio as the heat went along, and the lime was all cleaned up. As far as any detrimental effects of water spray on the basic brick in the checker area, I want to say that we have not had any trouble in this respect. We have watched this and were skeptical about it too but there is no cause for alarm. We have noticed that with the use of oxygen lances there is a lessening of heat input to the checkers as more heat is kept in the bath rather than swept downstairs with the flue gasses. So far we have not attempted to automate our lances to the extent that they will withdraw upon failure of coolant pressure. We have however constructed a system such that the lances cannot be lowered if the coolant pressure is below a preset level and the oxygen is not turned on.

A. T. Peters: I wanted to concentrate on one aspect, namely, the record-breaking heat and to ask two direct questions. Was it a low carbon heat or was the furnace tapped as soon as ready on a spring or rail or something like that? Second, what was the fettling time after this heat? My main comment deals with one aspect of the record heat which rather worries me. This is the remark about the presence of many supervisors on the floor. No doubt this heat was arranged especially. This is obvious, and was never hidden in the paper. There were no delays, superior organization alone accounting for better than doubling of the output. Maybe we are "barking up" the wrong tree. Perhaps a major road to improved performance is industrial engineering, training, education, and enforcement, not straightforward engineering. I would be glad if Mr. Thompson could give some of his opinions.

T. A. Thompson: First I will say that we made a 10 or 12 point carbon heat, and the fettling time after the heat was made was an hour. The banks of the furnace were not out, and it was not damaged.

On the supervision, we all have our views, and personally I think we are a little bit lax in getting the most from our people at all times. The matter of supervision we had for this particular heat was to fill in any gaps that might appear. We doubly supervised the material handling especially. We insisted on constant checking of the bath, lances, the depth of the lances. We just pushed everything and had everything ready when the time for the heat-to-tap arrived.

We have a problem in our shop that requires extra supervision—one of small hot metal ladles has to be organized very closely to move the tremendous amount of metal it takes to charge one of these big furnaces, and all these things were thoroughly gone over for that one heat.

S. Lawrence: Have you ever operated your furnaces with a single lance and if so how did the results compare with a multiple lance operation?

T. A. Thompson: We have large, deep baths, and we feel that we have to force as much oxygen as possible into those deep baths. We have many times dropped down to the single lance due to a loss of one of them. On our 450-ton and our 280-ton furnaces we have two lances. On our 550-ton and our 600-ton furnaces we have three lances. We try to use all the available oxygen we can, but whenever we loose a lance, we will operate in this manner and we have had good results with the single lance. In other words, the difference between two lances and three lances is not three to two and the difference between two lances and one lance is not two to one but rather something in between. We have for example quit operating three lances on the big furnaces without sacrificing too much furnace time. ▲

A Fresh Approach to Automatic Gage Control on Rolling Mills

. . . . by combining reduction measurements based on strip elongation thickness measurements, and automatic logic control with a computer, a control scheme has been developed which essentially eliminates transport time and distance . . . . successful use requires a mill with high speed screws . . . .

THIS paper will discuss a phase of the program of the electromechanisms dept., Brackenridge Works of Allegheny Ludlum Steel Corp. The area to be explored is that of automatic measurement and control of strip mills, though, with modification, the techniques are applicable to multi-stand mill control systems.

Our program called for the design, construction and testing of two component systems before the over-all system in which the elimination of transport time and distance was developed.

The first of these systems to be described will be a digital elongation measuring and control system. This system embodies the following desirable features:

1. Extreme accuracy over a wide elongation range.
2. No operator adjustments to the measuring system are necessary.
3. Simple set-in of desired control bands for use in automatic mill control.
4. Compatible with card preset and automatic data processing equipment.

The second system to be described is the digital gage. This is a contacting gage measuring device of the absolute type and is used as standard after-the-fact gage control. It embodies the following desirable features:

1. No operator settings or adjustments required to basic measuring system.
2. Requires no manual adjustments of zero, range, sensitivity, etc.
3. Automatically compensates for drift caused by such variables as temperature and wheel wear.
4. Simple set-in of desired control bands for use in automatic mill control.
5. Compatible with card preset and automatic data processing equipment.

The third system to be discussed will be the regal control. The word regal is derived from variable *Re*duction based on *E*longation and *G*age measurements coupled with *A*utomatic *L*ogic. The heart of the regal control system is a computer that in essence eliminates transport time and distance. This is possible because of the inherent characteristics of the basic information given to the computer. Briefly, the regal control system monitors the thickness of steel entering the mill. This gage information is stored in a memory device until the portion of steel enters the roll bite. Acting on the gage and elongation information at roll bite, the computer calculates the reductions required to produce the desired output gage. This will be further explained later in the paper.

AUTOMATIC DIGITAL ELONGATION CONTROL

This equipment has been designed to perform measurement and mill control of elongation of material by a sampling method. It is a digital device which solves the following equation:

$$\text{Per cent elongation} = \frac{L_2 - L_1}{L_1} \times 100$$

where

L_1 = an increment of entry length
L_2 = an increment of exit length

This paper was read by members of the Electro-Mechanisms Dept. of Allegheny Ludlum Steel Corp. before the Pittsburgh District Section, AISE on January 13, 1958. It has been re-edited by J. B. Murtland, Jr., manager, and F. J. Schoepf, application analysis engineer, Electro-Mechanisms Dept., Allegheny Ludlum Steel Corp.

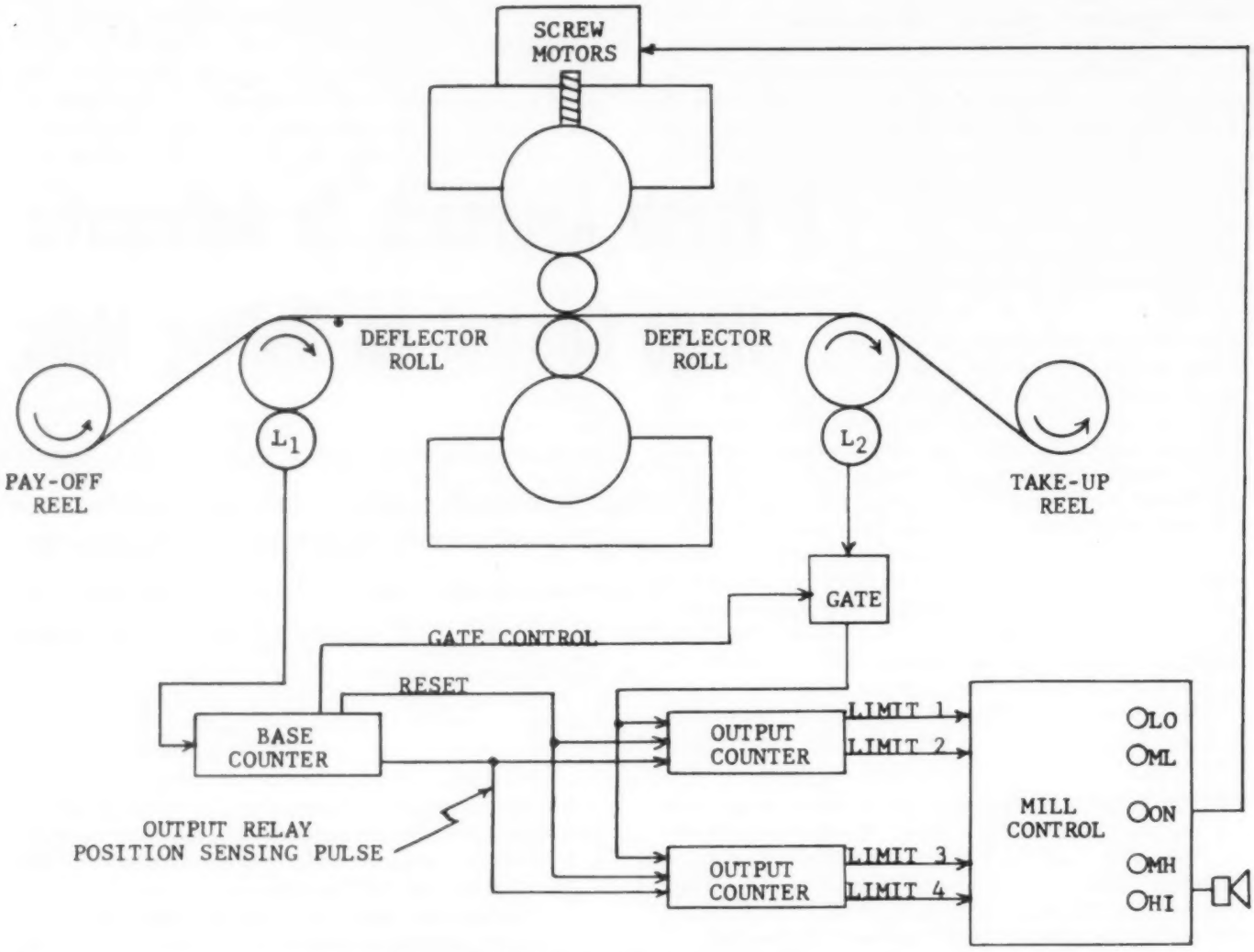


Figure 1 — Pulse counters are used to determine the elongation in the roll bite.

As material is processed through a mill, it is stretched or elongated such that there will be more lineal units of material leaving the mill than had entered. On both entry and exit sides of the mill, pulse generators are coupled to the strip either directly or through the idler rolls. These pulse generators change the analog quantity of length of strip into electrical pulses suitable for counting.

The following is the basic concept of how the measuring system operates and how incremental strip lengths are sensed and converted to direct reading per cent elongation.

As shown in Figure 1, the pulse generator on the entry side is coupled to an electronic pulse counter which is called the "base counter." Similarly, the pulse generator on the exit side is coupled through a gate to two "output counters." The base counter is set up to count to 10,000 electrical pulses at which time it stops both output counters by closing a gate. Assume that elongation was 10.00 per cent. Since it is known that enough material entered the mill to produce 10,000 counts and that the material was lengthened or elongated 10.00 per cent, the output counters after shutoff should read 10,000 plus 10.00 per cent of 10,000 or a total count of 11,000. Now assume that elongation was 5.60 per cent. The output counters in this case would read 10,000 plus 5.60 per cent of 10,000 or a total count of 10,560. Note that in each case if you take four adjacent numbers, starting from the right and insert a decimal point in front of the second, you have the elongation percentage directly displayed. This holds for any power of 10 to which the base counter is set. The only change necessary is the relocation of the decimal point.

The system as installed on one of our mills uses dual preset counters. The purpose of this type counter is to provide an electrical contact closure when the counter reaches the number that has been preset into it. For instance, if we were to set in the number 1-3-9-8-0 an electrical contact would close and hold when the counter registers 1-3-9-8-0 even though the counting continued. The contact will open again upon reset to zero. As the word dual implies, it is possible to set two such numbers in each counter. These numbers can be set in by either switches or cards.

On two output counters it is possible to preset four numbers, which are referred to as Limits 1 through 4. This results in five bands of operation. Mill control is initiated within these output counters.

Let us assume a typical set of conditions and see how the control operates. (Refer to Table I).

Suppose it is desired to have material elongated at 12.00 per cent. Term this "nominal elongation." However, it is decided that material elongated from

TABLE I

Band term	Associated panel lamp color	Control function	Per cent elongation	Limit number	Preset count
Heavy	Red	Automatic return to manual plus horn	14.00	4	11,400
Medium heavy	Amber	Raise screws for preset time	13.00	3	11,300
On	Green	No screw adjustment	12.00 (nominal elongation)		
Medium low	Amber	Screwdown for preset time	11.00	2	11,100
Low	Red	Automatic return to manual plus horn	10.00	1	11,000

11.00 to 13.00 per cent would be within tolerance. It is also decided that no automatic mill control should be permitted if the elongation is less than 10.00 or is 14.00 per cent or more.

Setting up the equipment is only a matter of presetting predetermined numbers into the counters. With a base count of 10,000, Limit 1 would be 10,000 plus 10.00 per cent of 10,000 or 11,000. Limit 2 would be 10,000 plus 11.00 per cent of 10,000 or 11,100. Limit 3 would be 10,000 plus 13.00 per cent of 10,000 or 11,300. Limit 4 would be 10,000 plus 14.00 per cent of 10,000 or 11,400. Setting in numbers at the four limits has actually provided electrical contact closures at these counts and above.

The base counter has provisions for presetting two limits designated "gate" and "reset." "Gate" count is set at 10,000 and performs the following functions:

1. Closes the gate which stops the two output counters.
2. Commands printer to print elongation if one is attached.
3. Commands in-line readout to display new elongation percentage.
4. Closes and holds a relay contact sending power through the relays in the output counters to sense their relative positions. The positions of these output counter relays are subsequently used to initiate machine control.

The base counter continues to count past 10,000 until it reaches the count set in "reset" (some number greater than 10,000). When coincidence at "reset" is reached, the following actions take place simultaneously:

1. Base counter resets to zero and starts counting.
2. Both output counters reset to zero.
3. The gate opens and the output counters begin to count.

If the output counters do not reach a count of 11,000 (less than 10.00 per cent elongation before gate off) there will be no relay contact closures. The control will automatically return the mill to manual operation, sound a warning horn and light a red warning lamp marked "low." This red warning lamp will remain on until a "reset" button is pushed, at which time the horn will stop and the red warning lamp will go out. "Low" denotes the low band which, in this case, ranges from 0.00 to 9.99 per cent elongation.

If the count on the output counters at gate off is from 11,000 to 11,099 the "Limit 1" relay will close. This contact closure will energize a timer which will energize the mill screwdown motor for a preset time and light an amber lamp marked "medium low" for the duration of the screwdown period. "Medium low" denotes the medium low band which, in this case, ranges from 10.00 to 10.99 per cent elongation.

If the count on the output counters at gate off is from 11,100 to 11,299, "Limit 1" and "Limit 2" relay contacts will both close. These relay closures will light a green lamp marked "on." "On" denotes the on elongation band which, in this case, is 11.00 to 12.99 per cent elongation.

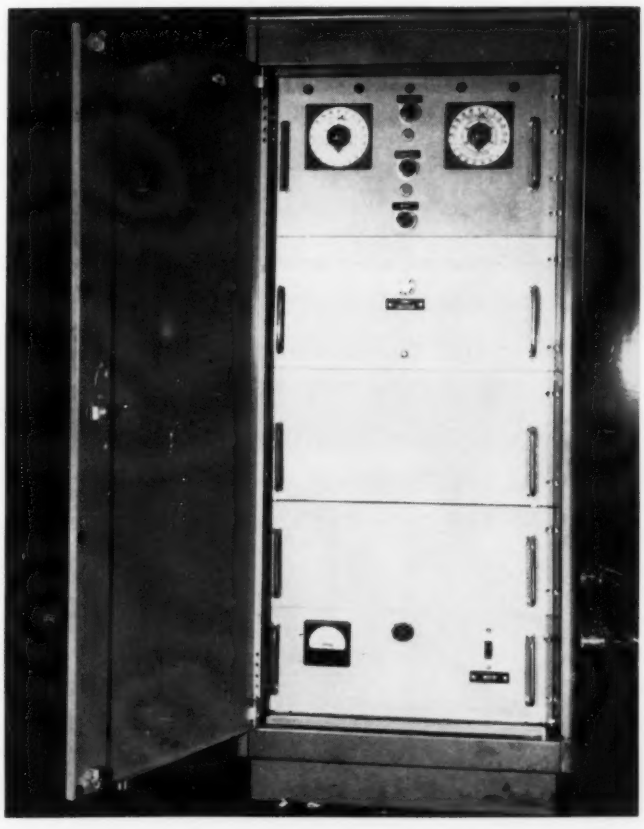
If the count on the output counters at gate off is from 11,300 to 11,399, "Limit 1," "Limit 2" and "Limit 3" relay contacts will close. These contact closures will energize a timer which will raise the screws for a preset time and light an amber lamp marked "medium high" for the duration of screw adjustment. "Medium high" denotes the medium high band which, in this case, ranges from 13.00 to 13.99 per cent elongation.

If the count on the output counters at shutoff is 11,400 or greater, "Limit 1," "Limit 2," "Limit 3" and "Limit 4" relay contacts will close. These contact closures will cause the control to automatically return the mill to manual operation, sound a warning horn and light a red warning lamp marked "high." The red warning lamp and horn will remain on until the "reset" button is pushed. "High" denotes the high band which, in this case, is 14.00 per cent or more elongation.

AUTOMATIC DIGITAL THICKNESS GAGE

An extensive study was made of our gage measurement requirements on cold rolling operations and the

Figure 2 — The automatic digital thickness gage controls output gage of the cold mill.



available gages and gaging techniques. As a result of this study, it was decided that a gage of the contacting type would meet most of our requirements. This type of gaging would suffice in all but a few cases providing some of the shortcomings of presently available commercial units were corrected. Our requirements for a contacting gage measuring system are as follows:

1. Automatically compensate for zero drift due to temperature wear, etc.
2. Adequate range so that no operator adjustments are necessary to the measuring system.
3. Absolute gage, indicating actual thickness decimally to the fourth place (as opposed to the deviation type).
4. High speed response.
5. To provide output signals compatible with automatic data recording and processing units.

This gage, when used as the measuring component in a gage control system, must also meet these additional requirements:

1. Insertion of mill control information by punched card or mill operator should be kept as simple as possible.
2. The output of the gage must furnish suitable signals for automatic mill control.

The automatic digital thickness gage shown in Figure 2 was designed to measure, indicate and control the output gage of a cold rolling mill in an after-the-fact gage control system. The equipment accepts analog information from contact type gage heads, converts it to digital form and continuously displays the actual gage number. The operators control panel (Figure 3) is equipped with pushbutton switches which are used by the operator to select the desired nominal gage and tolerance deviations. This information is continuously compared with the exit gage. When the exit gage deviates beyond the desired limits, an error is sensed in a relay logic matrix and corrective action occurs.

Figure 4 shows in block diagram form the layout of this gage. Basically it is composed of the measuring system, readout circuits, control circuits and circuits which automatically compensate for zero drift. The heart of this system is the servo and digital comparator units. A differential transformer mounted in the gage head and a balance transformer on a servo follower are the thickness sensing devices. A change in strip thickness results in error signals which drive a servo motor cam combination to balance the follower transformer core. This motor also drives decimal and binary shaft position digitizers. (The binary output is used for computational purposes in regal.) Shaft rotation of the decimal shaft position digitizer provides the analog to digital conversion necessary for digital comparison and readout. Information from switch closures in this shaft position digitizer operate relays in a digital comparator. This actual measured gage is continuously compared with the control information which is set in by the operator on his control panel pushbuttons. The circuits within the digital comparator determine whether the measured gage is above or below the preset control limits. Set-in of these limits results in five bands of operation whose functions are the same as those for the elongation control (see Table I).

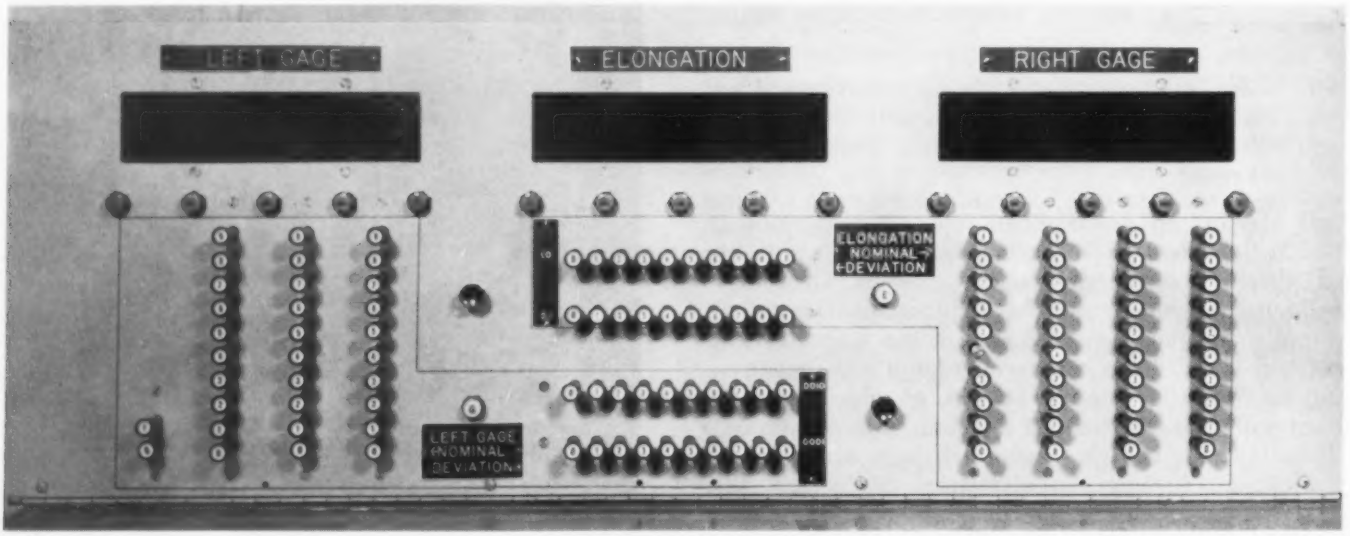
Every time the gage head is removed from the strip, a command signal is directed to the automatic zero circuitry to correct for zero drift error. When the shaft position digitizer reaches its zero position, a signal from the digital comparator disconnects and locks the digitizer. The servo motor drives the core of the balance transformer to null position. The circuits return to normal operating conditions when the gage is again put on the strip.

REGAL

In rolling mill gage control systems employing after-the-fact gage measurement, material after reduction passes to the gage which is several feet beyond the roll bite of the mill. The gage is then able to determine the strip thickness. This type of physical configuration puts serious limitations on the accuracy and response of the over-all control system. This comes about because of the attempt to control gage based on measurements taken one transport distance away from the point of reduction.

A system employing elongation measurement as a means of control has one basic advantage; the transport time of such a system is zero if the strip is under tension.

Figure 3 — Operators select desired nominal gage by pressing appropriate pushbutton switches.



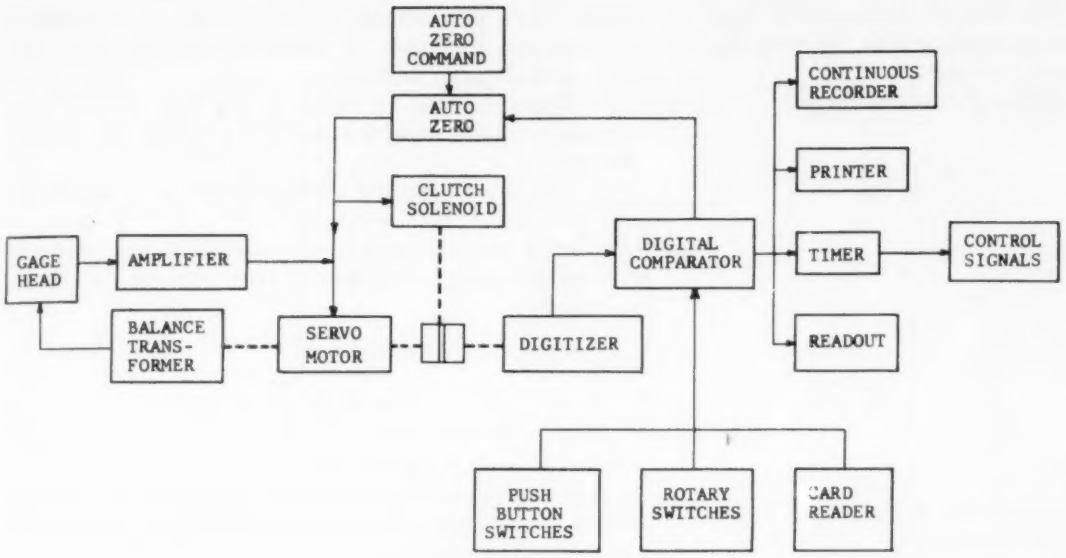


Figure 4 — Functional block diagram for automatic digital gage.

As described before, the strip length measuring devices may be placed at any distance from the roll bite of the mill. In the sampling type system, for a certain increment of length passing through the entry length measuring device, there will be an equal or greater increment of length measured at the exit device. The exit length is dependent on reduction. Since the transport time is zero, the only time delay in the system will be the time involved in sensing sample lengths. These increments can be made so short as to be ignored. Although it would appear that an elongation control would be desirable, further analysis shows a serious short-coming in this system. An elongation control system will not correct errors in gage but will tend to maintain the existing end-to-end strip profile.

The next step would be to combine the continuous range digital thickness gage and elongation control which have been previously described.

Consider that we have a cold reduction mill as shown in Figure 5, but now the thickness gage has been moved to the entry side of the mill rather than the exit as is the usual location. In addition, we have an elongation control which essentially measures the elongation at the bite of the mill. Now the problem becomes that of measuring the gage coming into the mill, knowing the gage desired on the output of the mill, and computing

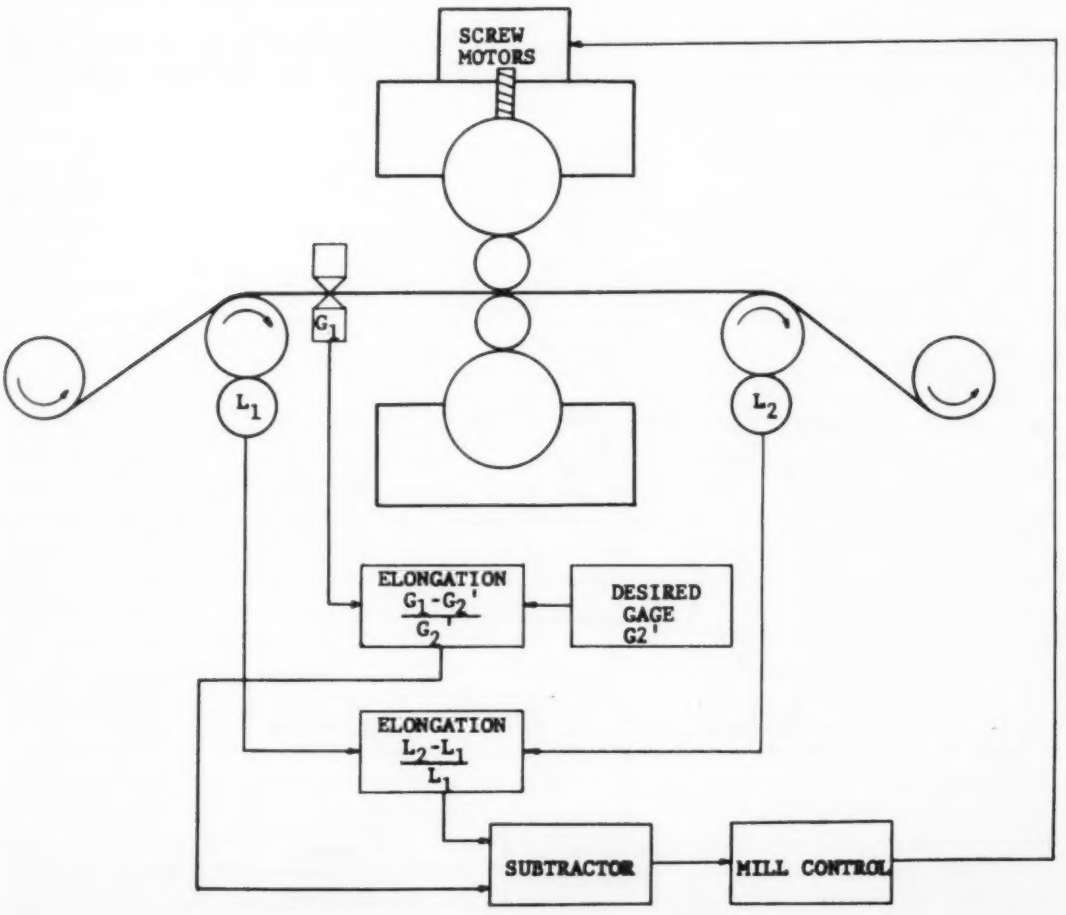


Figure 5 — Over-all control combines continuous range digital thickness gage with elongation controls.

the desired elongation. This desired elongation is then compared with the actual elongation and the resulting error signal used to control the mill.

The mathematical definition of this is as follows:

Assuming constant width,

$$\text{Per cent E} = \frac{L_2 - L_1}{L_1} \times 100$$

$$= \frac{G_1 - G_2}{G_2} \times 100$$

where:

L_1 = input length
L_2 = exit length
G_1 = input gage
G_2 = exit gage

Since G_2 actually represents desired gage, this equation may be written as follows:

$$\frac{G_1 - G_2'}{G_2'}$$

where G_2' = desired gage.

These relationships may be treated in a more general manner by assuming constant volume such that:

$$L_1G_1W_1 = L_2G_2W_2$$

where:

L_1 = input length
G_1 = input gage
W_1 = input width
L_2 = exit length
G_2 = exit gage
W_2 = exit width

Therefore $G_2 = G_1 (L_1W_1/L_2W_2)$.

Thus, if we measure the input gage, input length, input width, exit length and exit width, it is possible to compute the gage of material leaving the mill. The advantage is twofold:

1. Since L_1 and L_2 occur at the bite of the mill, we can properly compute the exit gage at the bite of the mill.
2. We are measuring thickness before it enters the roll bite.

Now by comparing the computed exit gage with the desired exit gage, it is possible to develop control signals as follows:

$$\text{Error} = G_2 - G_2'$$

$$= G_1 \frac{L_1W_1}{L_2W_2} - G_2'$$

where G_2' = desired exit gage.

It is now possible to eliminate the transport distance found in mill control systems which rely on gage measurement after-the-fact.

The solution to regal which we chose to use is developed from the equation:

$$\text{Error} = \frac{G_1L_1W_1}{L_2W_2} - G_2'$$

Assume for now that $W_1 = W_2$. Then:

$$\text{Error} = \frac{G_1L_1}{L_2} - G_2'$$

$$= \frac{G_1L_1 - G_2'L_2}{L_2}$$

Since the direction of the error is the only significant information, the equation evolves to:

$$\text{Direction of Error} = G_1L_1 - G_2'L_2$$

Figure 6 shows a simplified block diagram of the solution to this equation. In this block diagram L_1

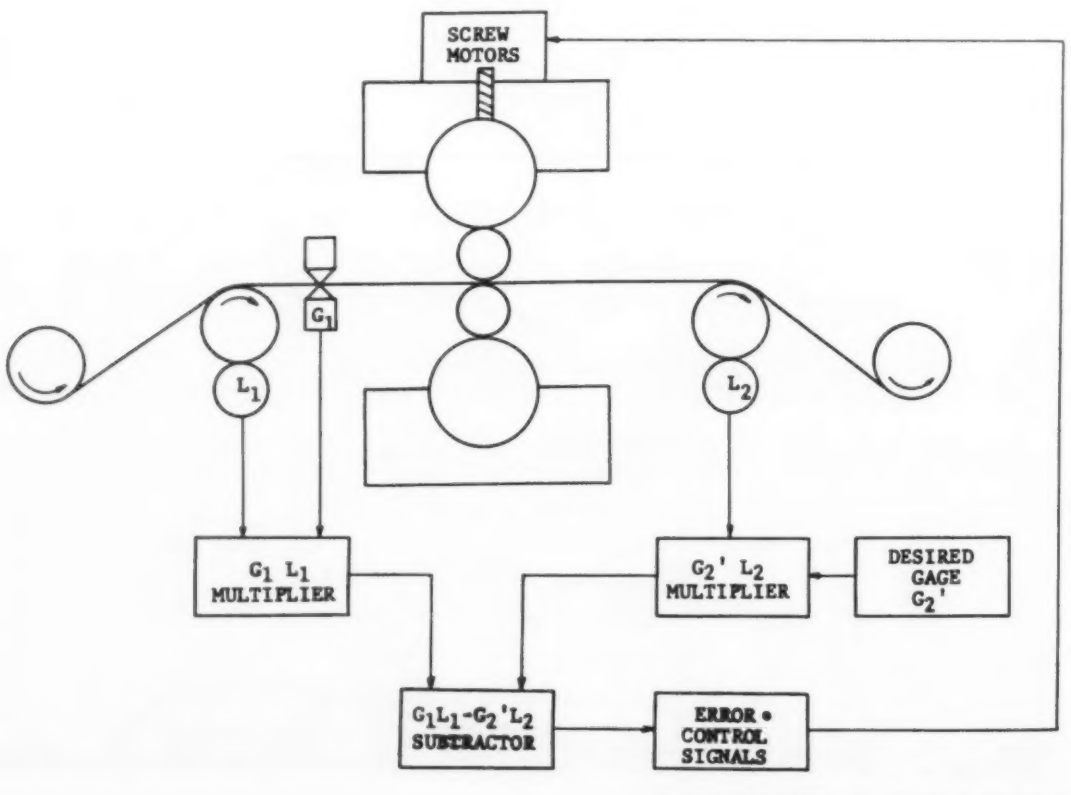


Figure 6 — This type control eliminates transport distance problem.

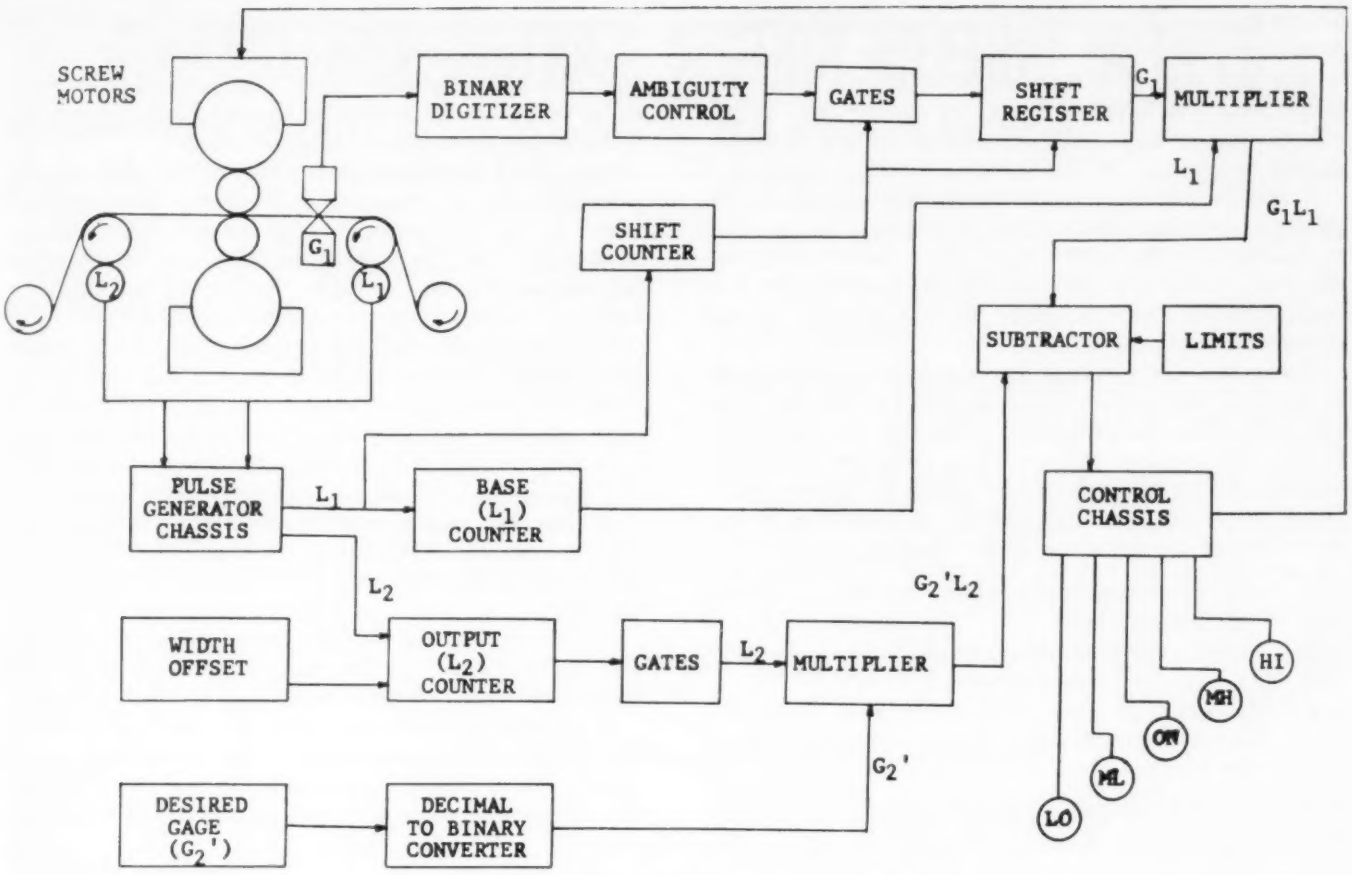


Figure 7 — Detailed block diagram of digital computer.

and G_1 are fed into a multiplier and L_2 and G_2' are fed into another multiplier. The products of these multipliers are then fed into a subtractor. If the sign of the remainder is plus, the screws need to be lowered. Conversely, if the sign of the remainder is negative, the screws need to be raised. If there is no remainder, there is no error and the equation is satisfied with the present screw setting.

A more detailed block diagram of a digital computer is shown in Figure 7.

Derivation of G_1—Since the computer works on the binary counting system, a binary shaft position digitizer is attached to the digital gage on the input side of the rolling mill. The "ambiguity control" is to insure continuity of the number output of the shaft position digitizer through its range.

Because the gage is on the input side of the rolling mill, the gage information on a particular unit of material must be remembered and inserted into the computer when this unit is approaching the roll bite. This is accomplished in the blocks marked "shift counter," "gates" and "shift register." Assume that the input measuring gage (G_1) is located 60 in. from the roll bite. Also assume that this 60 in. is equal to 10,000 pulses. It is determined that gage readings for every six in. of strip will be sufficient. This then results in a shift register unit capable of remembering eleven gage readings. The last stage of the shift register is nondestructive so that it may be used by the multiplier for several samples. The shift counter advances the shift register and operates the gates to admit a new gage reading into the shift register. In the example above, the shift counter would be set to put out a command pulse to the gates, shift register and then reset itself at a count of 1000.

Derivation of desired gage G_2'—Because the computer is a binary device and G_2' is set in manually by the mill operator in a decimal fashion, it is necessary to convert from decimal code to binary code. This is accomplished in the block labeled "decimal to binary converter" and supplies G_2' to the L_2G_2' multiplier in a binary form.

Derivation of L_1 and L_2—Pulse generators are mounted on the rolling mill on the input and output sides and so coupled to the strip to produce electrical pulses at a rate proportional to the length of strip entering and leaving the mill. The "input" pulses are coupled to the "shift counter" to activate the "shift register" and to the "base counter." The "output" pulses are coupled to the output counter. The "base counter" measures a certain length of material into the mill by counting electrical pulses. At the end of this sample length, an electrical pulse is used to initiate the following:

1. Opens the L_2 gates to record the count in the output counter in the L_2G_2' multiplier and commands the multiplication.
2. Inserts the L_1 count in the "base counter" into the L_1G_1 multiplier and commands multiplication.
3. Resets itself and the "output counter" and the system commences accumulating another sample.

"Width offset"—The block labeled "width offset" is coupled to the output counter. This is a variable reset on the L_2 output counter. If the material were to change in width during the rolling operation, the calculated

output gage would be in error by a proportional amount. Assuming the width differential to be a constant in any one coil, it is possible to determine what the proper count differential is and by setting the "width offset," cancel the effects of change in width which appear as changes in the calculated output gage.

Limits for subtractor—This block consists of manually operated switches which insert two symetrical + and − limits into the subtractor. These limits when set into the subtractor provide the framework for five band controls which is similar to that discussed in the elongation control.

Subtractor—The subtractor receives the products of the L_1G_1 and L_2G_2' multipliers and compares these products. After the subtractor arrives at the remainder, if any, it compares this with the arbitrary limits set into it by the block marked "limits for subtractor." Based on the sign and magnitude of the error, it initiates one of the following control actions:

1. Low gage—automatic return to manual control with warning horn.
2. Medium low gage—raise screws.
3. On gage—no control action.
4. Medium high gage—lower screws.
5. High gage—automatic return to manual control with warning horn.

Control chassis—The "control chassis" takes the control information from the subtractor and distributes control signals to the proper mill control components. It also contains various mill interlocks. It has built into it an electronic timer that permits the screws to be operative for a definite limited time per sample if there is an error involving screw action.

This paper has discussed a phase of the gage control program being carried out by Allegheny Ludlum Steel Corp. Since this paper was presented before AISE in January, 1958, the system described has been operating successfully on one single stand cold mill and has fully met expectations as a gage control system.

In order to fully utilize this equipment and to attain a high degree of efficiency from a mill, it has been found that the following pass sequence is highly desirable:

1. On the loading pass, if the material does not contract the idler roll, typical after-the-fact gage control should be used to iron out gross variations.
2. On the return pass, when correct tension has been achieved on both sides of the mill, the regal computer should be used to level the strip as rapidly as possible.
3. As soon as the strip is leveled within the limitation of the precision of the gages, the elongation control should be used to reduce the strip to the thinner gages.

It should be noted here that the successful use of the regal computer requires a mill with high speed screws. Many mills, at present, do not have the response necessary to take full advantage of this system. ▲

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CURRENT AISE DISTRICT SECTION MEETING NOTICES

BIRMINGHAM SECTION

Monday, April 25, 1960—Social Hour 6:30 P.M., Dinner 7:00 P.M., Meeting 8:00 P.M.

Paper to be announced.

Thomas Jefferson Hotel, Birmingham, Ala.

BUFFALO SECTION

Tuesday, April 12, 1960—Inspection Trip 2:30 P.M., Refreshments 5:00 P.M., Dinner 6:00 P.M., Meeting 8:00 P.M.

Inspection Trip 2:30 P.M.—Dominion Foundries and Steel Co. Ltd., Hamilton, Ontario, Canada

"Recent Installation at Dofasco," by D. O. Davis, Vice-President, Engineering, Dominion Foundries and Steel Co. Ltd., Hamilton, Ont., Canada

Dinner and Meeting, Prudhommes Garden Centre Hotel, Vineland, Ont., Canada

CANTON SECTION

Monday, April 18, 1960—Dinner 6:30 P.M., Inspection Trip 7:30 P.M.

Inspection Trip to Morgan Engineering Co., Plant, Alliance, Ohio

Dinner, Alliance Country Club, Alliance, Ohio

CHICAGO SECTION

Tuesday, April 5, 1960—Dinner 6:15 P.M., Meeting 7:45 P.M.

"Five-Zone Slab Furnace at South Works," by George Krapf, Division Superintendent, Power Production, South Works, United States Steel Corp., Chicago, Ill.

Phil Smidt's Restaurant, 1205 North Calumet Avenue, Hammond, Ind.

CLEVELAND SECTION

Tuesday, April 19, 1960—Social Hour 6:00 P.M., Dinner 6:30 P.M., Meeting 7:45 P.M.

Details Not Available.

Cleveland Engineering & Scientific Center, 3100 Chester Avenue, Cleveland, Ohio

COLORADO SECTION

Tuesday, April 19, 1960—Social Hour 6:30 P.M., Dinner 7:00 P.M., Meeting 8:00 P.M.

"Blast Furnace Operations," by J. W. Carlson, Superintendent, Blast Furnace Dept., The Colorado Fuel and Iron Corp., Pueblo, Colo.

Minnequa University Club, Pueblo, Colo.

DETROIT SECTION

Tuesday, April 12, 1960—Dinner 6:30 P.M., Meeting 8:00 P.M.

Great Lakes Steel Corp. Night

Election of Officers for 1960–61

"Effects of Beneficiated Burden on Blast Furnace Production"—Panel Discussion by W. H. Collison, Plant Superintendent, Blast Furnace & Coke Works, Great Lakes Steel Corp.; D. Joyce, Vice-President—Operations, Algoma Steel Corp., Ltd.; Paul E. Lindberg, Jr., Superintendent Hot Metal Div., McLouth Steel Corp.; and Wm. R. Kiessel, Supervisor Applied Research Section, Steel Div., Ford Motor Co.; Moderator: Carl Hogberg, President, Michigan Limestone Div., United States Steel Corp.

Dinner and Meeting—Dearborn Inn, Dearborn, Mich.

LOS ANGELES SECTION

Monday, April 11, 1960—Social Hour 6:30 P.M., Dinner 7:00 P.M., Meeting 8:00 P.M.

"Retaining Flexibility in the Design of Mechanized Merchant Bar Mills," by E. C. Peterson, Vice-President, Rolling Mill Equipment Div., and William H. Boblitz, Roll & Mill Machinery Sales Engineer, Birdsboro Corp., Birdsboro, Pa.

Holiday Inn, Chino, Calif.

PHILADELPHIA SECTION

Saturday, April 2, 1960—Dinner 6:00 P.M., Meeting 7:00 P.M.

"Features of New 140-In. Roughing and Slabbing Mill at Lukens Steel Company" "Automation" by C. W. Burdick, Electrical Engineer, Engineering and Construction Div., Lukens Steel Co., Coatesville, Pa.

"Rectifier and Main Drive for the New 140-In. Roughing and Slabbing Mill," by Gilbert P. Cardwell, Electrical Design Engineer, Engineering and Construction Div., Lukens Steel Co., Coatesville, Pa.

"Operations" by William J. Reilly, Supervisor of 140/206-In. Mills, Lukens Steel Co., Coatesville, Pa.

Engineers' Club, 1317 Spruce Street, Philadelphia, Pa.

PITTSBURGH SECTION

Monday, April 11, 1960—Social Hour 6:00 P.M., Dinner 7:00 P.M., Meeting 8:00 P.M.

Presidential Night

"Investigation of Spalling of Work and Backup Rolls in Hot and Cold Strip Mills," by James V. Latorre, Research Engineer, and M. K. Chakko, Metallurgical Research Laboratory, Syracuse University Research Institute, Syracuse, N. Y.

S. C. Read, President, AISE, 1960, and Director, Construction and Maintenance, Jones & Laughlin Steel Corp., Pittsburgh, Pa., will make his official visit to the Pittsburgh AISE Section.

University Club, University Place, Pittsburgh, Pa.

ST. LOUIS SECTION

Wednesday, April 20, 1960—Social Hour 6:00 P.M., Dinner 7:00 P.M., Meeting 8:00 P.M.

"Recent Developments in Overhead Cranes," by E. H. Burke, Vice-President in charge of Engineering, Morgan Engineering Co., Alliance, Ohio

Elks Club, Granite City, Ill.

SAN FRANCISCO SECTION

No April Meeting

UTAH SECTION

Monday, April 11, 1960—Social Hour 6:30 P.M., Dinner 7:30 P.M., Meeting 8:30 P.M.

"Oxygen in Steelmaking," by J. H. Zimmerman, Manager, Gas Processes, Linde Co., Div. of Union Carbide Corp., New York, N. Y.

Grand View Cafe, Provo, Utah

YOUNGSTOWN SECTION

Monday, April 18, 1960—Social Hour 6:00 P.M., Dinner 7:00 P.M., Meeting 8:00 P.M.

"Rubber Belt Conveyors in Steel Plants—Their Application, Maintenance and Operation," by Martin Vanderlaan, Manager of Operations, Engineers Div., Hewitt-Robins Co., Stamford, Conn.

Mahoning Country Club, Girard, Ohio

Aluminum Flat Products Now Produced at Omal, Ohio, Plant

FOUR hot and cold reduction mills at Olin Mathieson Chemical Corp.'s new Omal, Ohio plant produce 10,000,000 lb a month or better of flat aluminum products. Gages range from slab and plate down to 0.006-in. strip in widths up to 66 in. Plate widths can go to 90 in.

The mills, designed and built by by E. W. Bliss Co.'s rolling mill division, Salem, Ohio, include a 30/36-in. and 55-in. x 96-in. four-high reversing hot mill used for breakdown, a 21-in. and 53-in. x 80-in. four-high tandem hot finishing train, a 21-in. and 53-in. x 72-in. four-high, 2-stand tandem cold mill, and a 12/16 in. and 53-in. x 72-in. four-high single stand cold mill. Besides the mills, Bliss supplied the auxiliary equipment, including roller tables, side trimmers, edgers, shears, scrap choppers and coil handling equipment.

Rolling cycle at Omal begins with 10,000 lb aluminum ingots ranging up to 16 in. in thickness. A series of passes in the reversing hot mill reduces these to ½-in. or less. Width of the slab is controlled by a vertical edger. The plate produced moves down the runout table to a 2 x 96-in. upcut shear where its ends are trimmed. If it is to undergo further rolling, it continues along the 354-ft powered roller table to a second shear and a side trimmer followed by the tandem hot mill, where the hot finish rolling is accomplished.

As it is delivered from this mill, its edges are automatically trimmed and the material is coiled on a tension reel equipped with a horizontal belt wrapper. This coiling arrangement for a hot mill is made practical by the relatively low temperatures used in hot rolling aluminum.

The coils of hot rolled aluminum strip are then transferred to the tandem cold mill. Strip arriving at this mill ranges in gage from 0.140 to 0.250-in., and can be rolled to 0.012-in. finished thickness in several passes from the second stand. The mill can roll widths up to 66 in. and the dual uncoiling equipment, which includes a bridle unit and a coil box for the heavier gages as well as mandrel-type payoff reel and tension reel with horizontal belt wrapper for the lighter gages, can handle 10,000-lb coils.

The cold finishing mill is a four-high single-stand mill capable of cold reducing aluminum from 0.150 to 0.006 in. in several passes at speeds as high as 2500 fpm. Feed and coiling equipment includes mandrel-type payoff reel on the entry side, and tension reel and horizontal belt wrapper on the delivery side.

In addition to the mills and auxiliary shearing, trimming and edging equipment, Bliss' Rolling Mill Division designed and furnished all of the auxiliary equipment such as the hydraulic systems, coolant system, filtration systems, etc.

The new Omal rolling plant uses aluminum ingot supplied by the refining facilities of Ormet, a joint venture undertaken by Olin Mathieson and Revere Copper and Brass. Ormet operates refineries at Ormal and at Burnside, La., processing bauxite ore mined in Surinam. ▲

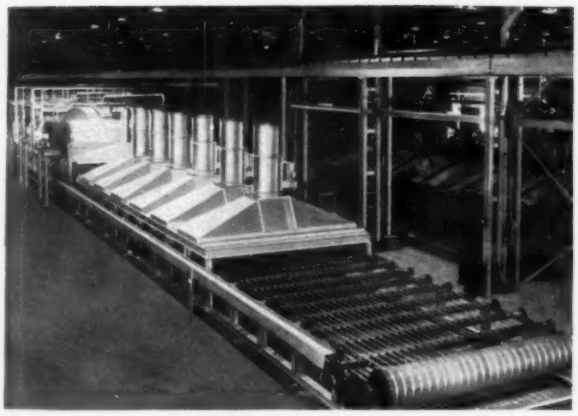
Figure 1 (left) — Four-high, two-stand tandem cold reduction mill at Olin Mathieson's new Omal, Ohio, aluminum rolling plant delivers aluminum in gages as thin as 0.012 in. in several passes, in widths up to 66 in.

Figure 2 (right) — This 21-in. and 53-in. by 80-in., four-high hot finishing train at Olin Mathieson's new Omal plant delivers hot rolled aluminum strip which can be sold as reroll product or further reduced in Omal's cold reduction mills. It delivers coils of material up to 72 in. wide weighing as much as 10,000 lb.

Charging end of Rust aluminum sheet, annealing furnace (one of two) for Reynolds Metals Company. Over-all length is 175', with 12' inside width.

ALUMINUM SHEET ANNEALING FURNACE

with new type of band conveyor designed and constructed for Reynolds Metals Company, Listerhill, Alabama.



Discharge end of annealing furnace. A new type band conveyor minimizes the marking of the aluminum sheets.

This modern Rust furnace is designed to anneal hourly 12,000 lbs. of aluminum sheets, 0.01" to 0.25" thickness in random sizes up to 144" wide. A new type of band conveyor minimizes (often completely eliminates) marking of the aluminum sheets by the furnace conveyor. Individually tensioned stainless steel bands are spaced to accommodate a variety of sizes and shapes of aluminum products.

Heating is accomplished with 100% forced convection. Massive volumes of recirculated gases maintain the customary requirement of ±5° F in a temperature range of 325° F to 950° F (determined by alloy and heat treatment desired) for the heaviest loads.

Reduced rates of recirculation provide the same temperature uniformity for lighter loads and prevent whipping of lighter gauge aluminum sheets.

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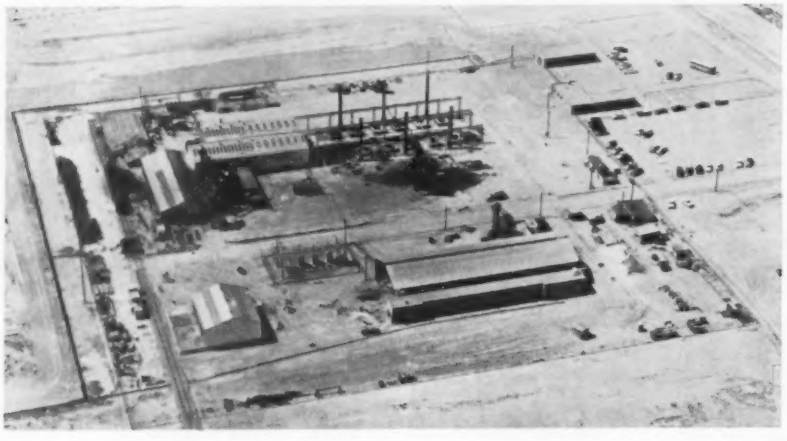

The GLC graphite plant at Antelope Valley, California.

We are glad to inform the electrometallurgical and electrochemical industries in the Western States area that we recently acquired the plant and physical assets of Crescent Carbon Corporation in California.

Carbon and graphite users in the Western States and those overseas in the Pacific area will shortly have a greatly improved source of supply at their command.

Plans now under way at the GLC graphite plant, Antelope Valley, California, call for a substantially increased inventory of electrodes, anodes and mold stock, not only in tonnage but in a variety of shapes and sizes as well. Customers can look forward to faster service on their shipments and to closer cooperation in solving their technical problems.

Technicians from our plants at Niagara Falls, N.Y. and Morganton, N.C. are establishing the most modern production techniques at the Antelope Valley plant, so that its products will meet established GLC standards of quality and uniformity.

As these forward steps are taken, we hope to have the privilege of widening the scope of our service to customers, old and new.

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Vacuum Fusion Provides Quick Gas Analysis of Metals

by V. S. McMULLEN, Chemist, Vanadium Corp. of America

As more critical specifications are applied to metals, it has become increasingly necessary to measure the exact quantities of impurities present. Gaseous impurities are particularly important since hydrogen, nitrogen and oxygen greatly affect the physical properties of metals. For example, the presence of hydrogen in steels can cause brittleness and cracking; oxygen in the refractory metals causes them to lose ductility and workability.

The determination of the amount of gas contained in metals is important, and vacuum fusion is a special analytical tool available which, although known for some years, has only recently been applied in gas analysis on a production basis.

The principle of analysis by vacuum fusion is not complicated. A representative sample is introduced into a high vacuum system and melted in a carbon crucible. As the melting takes place, any gases present are released and hydrides, nitrides and oxides are decomposed. Oxygen reacts with carbon from the crucible to form carbon monoxide.

The released gases are pumped to another section of the system where hydrogen is separated from the nitrogen and carbon monoxide. This may be done in a variety of ways, but the Serfass-Fisher equipment used by Vanadium Corporation of America performs this separation uniquely. The method: a heated palladium tube permits the passage of hydrogen but retains other gases. Quantitative estimation of the isolated hydrogen is accomplished by measurement of its pressure and volume. Then, after measuring the pressure-volume ratio of nitrogen and carbon monoxide, the latter is catalytically transformed into carbon dioxide and is absorbed from the gas stream. So sensitive is the system that as little as 0.0002 per cent of gas content may be analyzed by vacuum fusion.

Hydrogen and oxygen values may be determined with quite reasonable accuracy by vacuum fusion, but nitrogen values are considered to be unreliable since nitrogen escaping from the molten metal tends to combine with the cooler metal farther up the sides of the crucible. At this point, nitrogen analyses are lower than the true values. On further heating the recombined nitrides may decompose, releasing quantities of gas which may be either higher or lower than the amounts actually present.

As in all chemical analysis determinations, it is necessary to obtain representative samples in order to obtain analyses typical of the entire lot. This is best done by sampling from several locations of the solid or crushed metal or by sampling the metal while it is still molten. The latter procedure is most often used in sampling steel for hydrogen. Here, the samples are immediately cooled and kept in a bath which is several hundred degrees below the freezing point of water in order to prevent the loss of hydrogen by diffusion. At normal temperatures this loss begins at once and continues at a decreasing rate until a certain hydrogen level is reached.

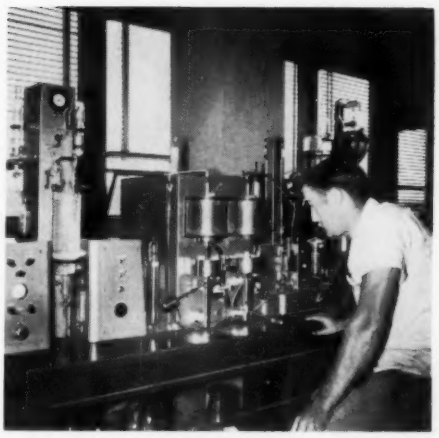


Figure 1 — Vacuum fusion provides quick and accurate gas analyses of metals.

Typical of the problems capable of solution with the aid of vacuum fusion analysis is the one of whether or not wet raw materials add hydrogen during steelmaking. Vacuum fusion is increasingly being relied upon to provide information which is helpful in learning why metals behave as they do. ▲

Alan Wood Initiates $36,000,000 Expansion Program

A CAPITAL expenditures program valued at approximately $36,000,000, to be spent over the next two years, was announced in February by Alan Wood Steel Co. of Conshohocken. The expansion has been made possible by completion of a $30,000,000 financing program, according to Harleston R. Wood, company president. This is the first step in a contemplated ten-year expansion plan.

Placed by the First Boston Corp., New York investment bankers, the financing consists of two loans. The major borrowing amounts to $22,500,000 and consists of 20-yr, 6 per cent first mortgage bonds. The secondary issue is made up of 6¼ per cent subordinated convertible debentures. These latter total $7,500,000 and have a life of 25 years. The bonds and debentures have been placed with the New York Life Insurance Co. and The Prudential Life Insurance Co., both of which will take one half of each issue.

These funds will be used to construct a new blooming mill and plate mill. The mills will replace the company's present blooming and plate mills, and will be located in a new mill building which will be constructed adjacent to Alan Wood's existing hot strip mill. The present mills will continue to operate during the construction period. They will then be dismantled and the buildings used for future expansion.

The new blooming mill will roll ingots into slabs to be used in both the new plate mill, and the company's present 30-in. hot strip mill. The new facility will be a 40-in. high-lift mill capable or rolling slabs up to 54-in. in width.

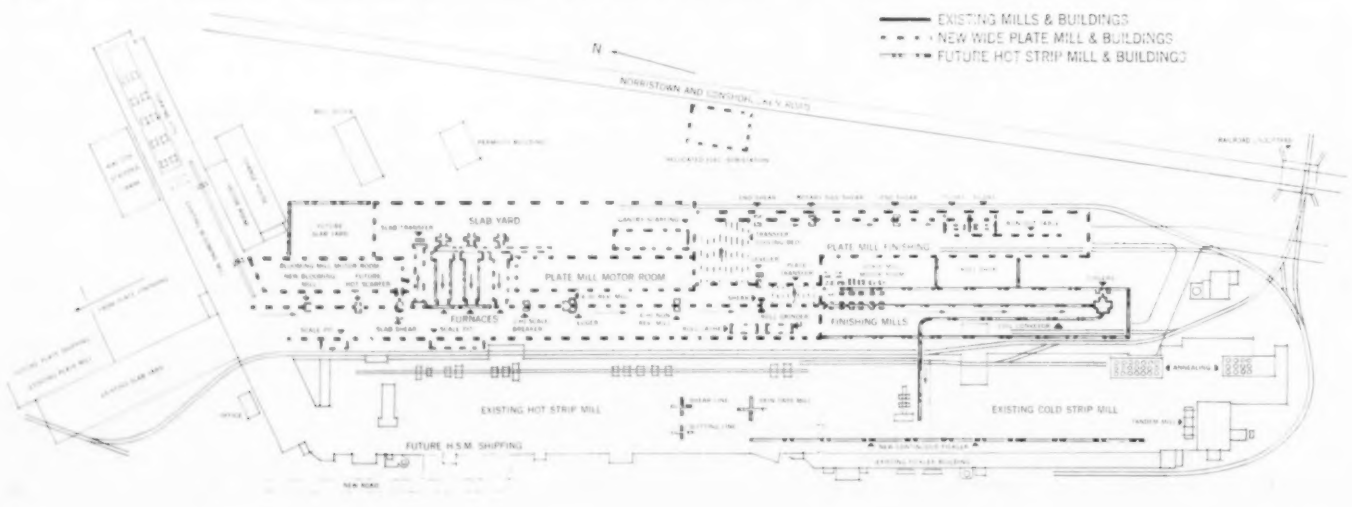
The other major portion of step one is a new 110-in. plate mill which will be erected in the new building. The new wide-plate mill will consist of three stands in line, capable of rolling plates up to 96-in. wide, sheared width. The third stand will be used for impressing the pattern on the company's "Super Diamond" floor plate. When not producing floor plate, this mill will be used to make a light reduction, which should improve the flatness and gage of Alan Wood's plain plate product.

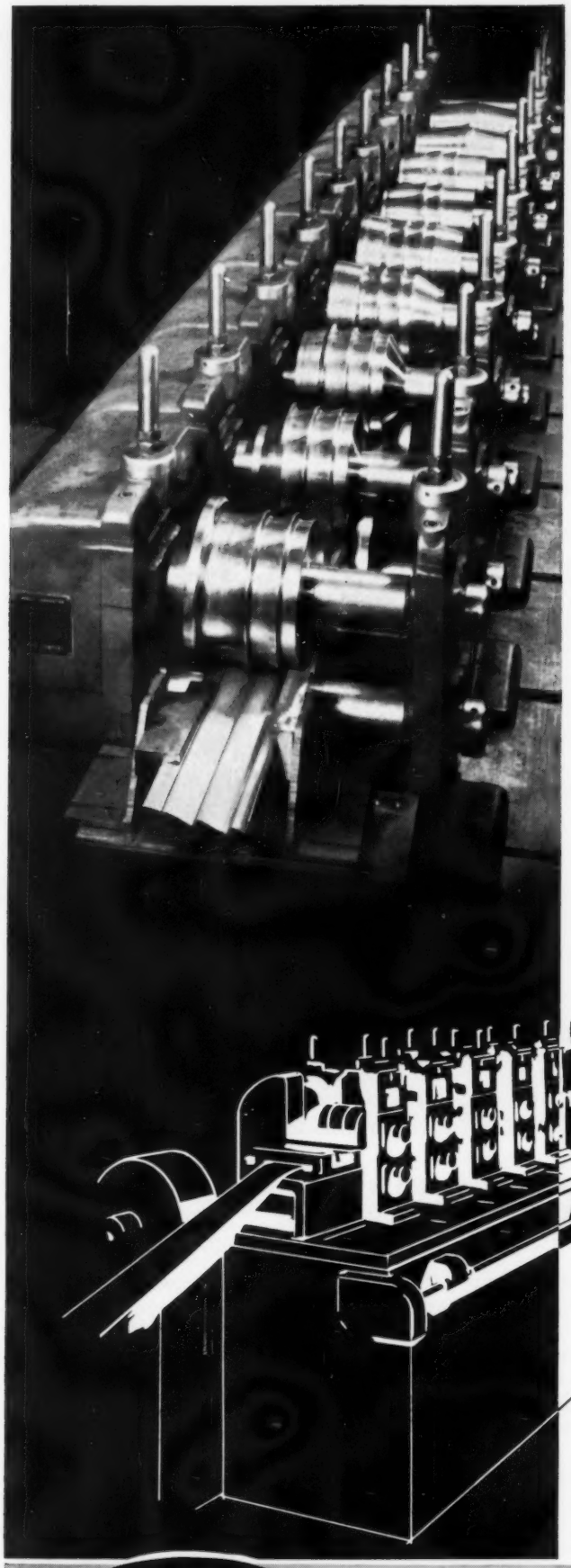
The plate mill will be equipped with high-pressure water (up to 1500 psi) for descaling. The company anticipates that plates will be finished with little or no rolled-in scale. This mill will have connected horsepower of 17,500, as contrasted with 5000 hp in the present plate mill. In the new blooming mill, the total connected horsepower will be 6000 as contrasted with 3500 hp in the present mill.

The new building will be constructed of structural steel and sheeting and will encompass 261,000 sq ft of floor space. Contracts already have been placed for the excavation and construction of the mill building. Blooming mill equipment has been ordered from the Birdsboro Corp., while plate mill machinery will be furnished by Mesta Machine Co. Work will commence immediately, with completion expected by the middle of 1961. Because the mills will be erected in a new building, all of the company's present facilities will operate throughout the construction period, thus assuring a steady flow of products to the company's customers.

Further expansion is contemplated and tentative plans have been made for its implementation. However, no timetable for this portion of the expansion program has as yet been established. ▲

Figure 1 — Layout of Conshohocken plant shows equipment proposed for future.





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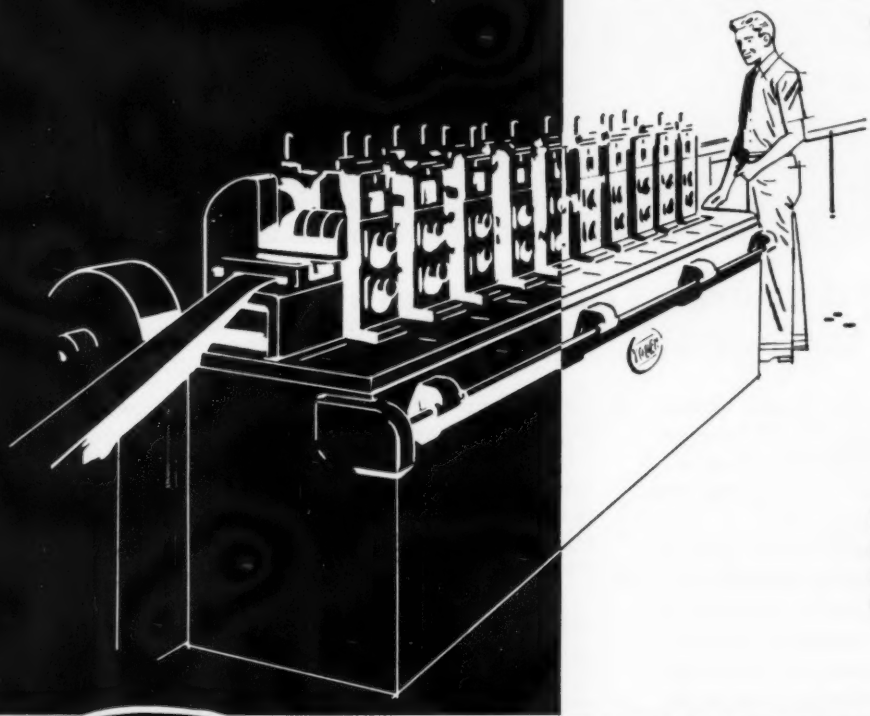

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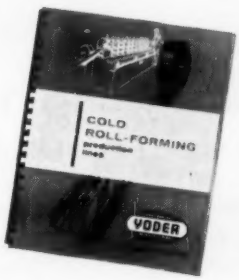

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PIPE AND TUBE MILLS (ferrous or non-ferrous)
ROTARY SLITTING LINES

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The new high-pressure hydraulic tool, shown above, is currently saving thousands of dollars for companies in the refining, chemical, and petrochemical industries. It is the jetting tool developed by Dowell to remove deposits from heat exchanger tube bundles.

Previous methods of cleaning these bundles have been costly, time-consuming and often inadequate. Many times bundles had to be replaced completely because of the lack of a suitable cleaning method.

This new tool has a remarkable record of thorough, fast cleaning. For example, a slurry reboiler exchanger bundle, three feet in diameter and 16 feet long, was fouled with deposits of coke and asphalt. After being jetted from only one side, the bundle was thoroughly clean. Time required: less than one hour.

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DIVISION OF THE DOW CHEMICAL COMPANY

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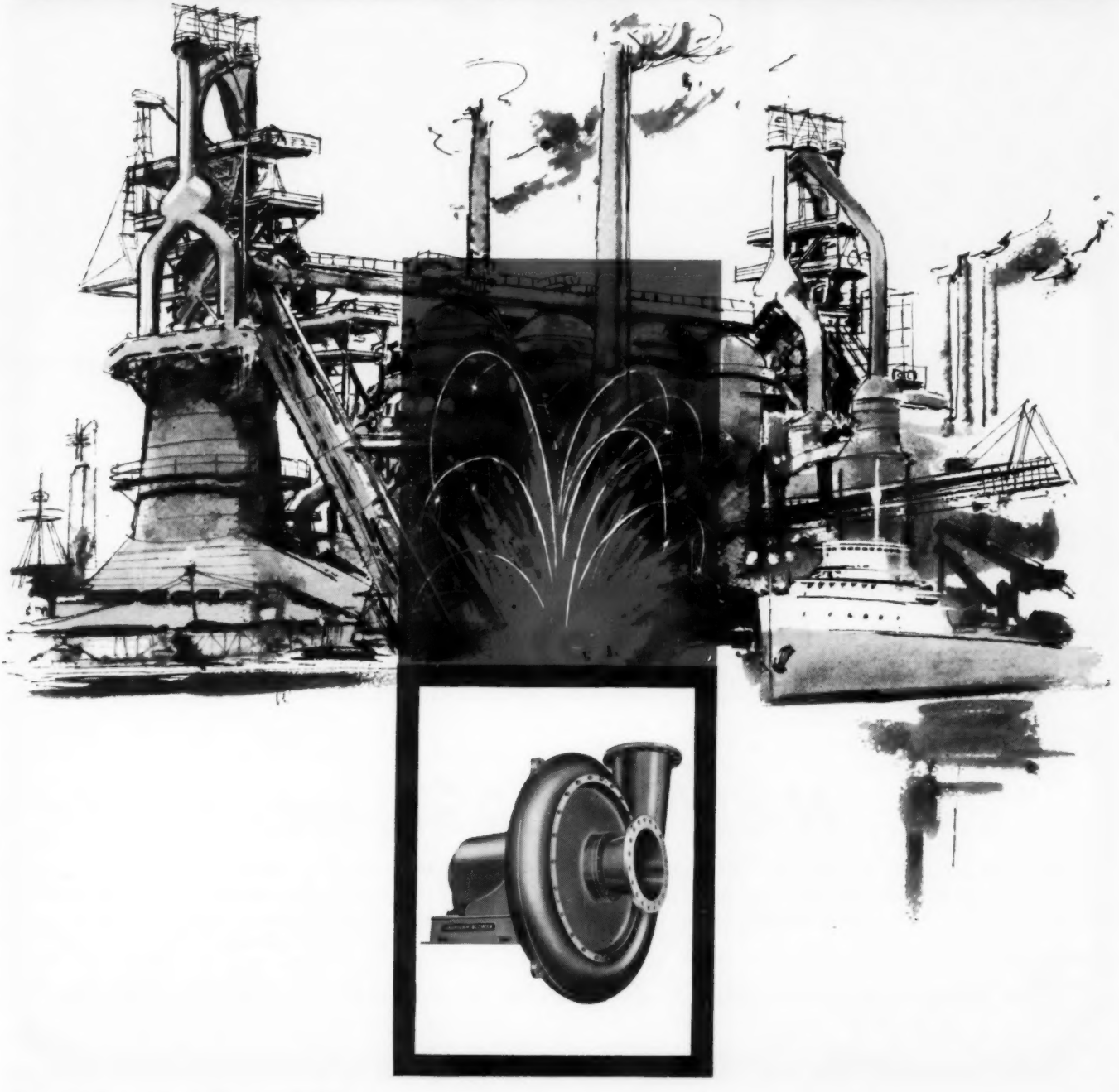

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LARGEST INDEPENDENT MANUFACTURER OF ABRASIVES — PRODUCING THE FINEST STEEL, MALLEABLE AND CHILLED SHOT AND GRIT ON THE MARKET

Date-line Diary...

February 1

△The American Iron Ore Assn. and AISI joint report indicates receipts of iron ore and ore agglomerates in the U. S. for the month of November, 1959, totaled 11,603,915 gross tons compared with 9,323,521 tons for November, 1958; stocks on hand as of November 30, 1959, totaled 66,968,300 gross tons compared with 71,316,426 gross tons as of November 30, 1958; total consumption in November, 1959, was 7,091,068 tons compared with 9,261,709 tons in November, 1958. There were 221 blast furnaces operating as of November 30, 1959, compared with 193 in the same period of 1958.

△The AISI reports that the operating rate of the steel industry for the week of February 1 is scheduled at 2,687,000 tons (94.3 per cent of capacity). This compares with 2,717,000 tons one week ago (95.4 per cent capacity) and 2,288,000 tons one year ago. Index of production for the week is 167.3.

February 2

△Shareholders of Latrobe Steel Co. approved a 2-for-1 split of $5.00 par value common stock; present authorization covers issuance of 4,000,000 shares at $2.50 par value.

△Auto assemblies in January, 1960, totaled 688,756 cars, 26 per cent higher than in January, 1959.

△Directors of International Nickel Co. voted a 2-for-1 stock split, subject to ratification at shareholders meeting in April; dividend of 65¢ was raised to 75¢, and, assuming continuance of the current outlook, the new shares will carry a 37½¢ quarterly dividend.

February 3

△The Commerce Dept. reported that manufacturers' inventories on December 31, 1959, were valued at $52,300,000,000, $700,000,000 over the November 30, 1959, evaluation. Manufacturers sales of goods in December, 1959, amounted to $30,800,000,000, up $1,800,000,000 over November, 1959, sales.

February 4

△The Commerce Dept. reported that steel exports in 1959 totaled 1,500,000, while imports totaled 4,400,000 tons. About 90 per cent of the imports were supplied by Western Europe and Japan.

February 5

△Retail auto sales in January, 1960, totaled 455,000 cars, up 10.6 per cent from January, 1959.

△The Commerce Dept. reported that total U. S. imports in 1959 reached $15,200,000,000.

△The Bureau of Mines reported that production of Pennsylvania anthracite for January, 1960, was 1,634,000 net tons compared with 1,860,000 net tons in December, 1959, and 2,194,000 net tons in January, 1959.

February 8

△The AISI reports that the operating rate of the steel industry for the week of February 8 is scheduled at 2,690,000 tons (94.4 per cent of capacity). This compares wih 2,683,000 tons one week ago (94.2 per cent capacity), and 2,371,000 tons one year ago. Index of production of the week is 167.5.

△The Aluminum Assn. reports that shipments of aluminum sheet and plate in December, 1959, totaled 121,632,000 lb compared with 106,152,000 lb in November, 1959; shipments for the year 1959 totaled 1,507,669,000 lb. Shipments of aluminum foil in December, 1959, totaled 17,852,388 lb compared with 18,408,319 lb in November, 1959, shipments for the year 1959 totaled 241,197,833 lb.

February 11

△Prices of scrap steel declined in Pittsburgh with a major railroad selling brokers and dealers No. 1 railroad scrap at $45.30 a ton, down about $3.70 a ton from sales a month ago.

February 12

△The Labor Dept. reported that employment in January, 1960, totaled 64,000,000, about 1,900,000 lower than December, 1959, and 1,000,000 above January, 1959; unemployment in January, 1960, totaled 4,150,000, an increase of 600,000 over the December, 1959, total.

△The AISI disclosed that steel production in January set a monthly record being slightly over 12,000,000 tons, compared with output of 11,900,000 tons in December, 1959, and 9,300,000 tons in January, 1959. Shipments of finished steel products in 1959 amounted to 69,300,000 tons, 16 per cent over 1958 shipments.

February 15

△The F. W. Dodge Corp. reports that total construction contracts in the United States (excluding Alaska and Hawaii) in 1959 amounted to $36,269,000,000 a gain of 3 per cent over 1958.

△Latrobe Steel Co. filed a registration statement with the SEC seeking registration of 116,000 shares of capital stock, 60,000 shares are to be offered for public sale by the company, and 56,000 shares by certain present stockholders.

△Directors of Detroit Steel Corp. approved a plan by which the corporation proposes to acquire controlling interest in Portsmouth Corp. Under the plan, Detroit Steel will offer all Portsmouth shareholders an opportunity to exchange holdings of Portsmouth common for Detroit Steel common at the rate of 1.55 shares of Detroit for each share of Portsmouth.

△Federal Housing Chief Mason reported that private housing starts in January, 1960, fell to a yearly rate of 1,210,000, down 9 per cent from December rate.

△The AISI reports that the operating rate of the steel industry for the week of February 15 is scheduled at 2,699,000 tons (94.7 per cent of capacity). This compares with 2,687,000 tons one week ago (94.3 per cent capacity) and 2,449,000 tons one year ago. Index of production for the week is 168.0.

February 16

△Britain's exports in January, 1960, totaled $885,000,000, compared with $831,000,000 in December, 1959. Imports in January were down from December, resulting in adverse trade balance in January, 1960, of $109,000,000, compared with $179,000,000 in December, 1959.

△Alan Wood Steel Co. completed a $30,000,000 financing program for their expansion program which includes construction of a new blooming mill, capable of rolling slabs up to 54 in. wide, and new plate mill capable of rolling plates up to 96 in. wide and 4 in. thick.

February 17

△Steel scrap prices in Chicago dropped about $2.00 a ton, one large mill is offering $41.00 a ton for No. 1 industrial heavy melting steel down from $43.00; another mill reduced price to $40.00, down $2.00 from price a week ago.

△The ARCI reported that deliveries of new freight cars in January, 1960, totaled 2849 compared with 3032 cars in December, 1959, and 1940 in January, 1959. Sales in January totaled 7149 compared with 10,560 in December, 1959, and 4007 in January, 1959. Backlog of cars on order as of February 1, 1960, was 48,170 compared with 43,870 on January 1, 1960, and 29,470 on February 1, 1959.

△The American Iron Ore Assn. and AISI joint report indicates that receipts of iron ore and ore agglomerates in the U. S. for the third quarter of 1959 totaled 16,548,110 gross tons compared with 36,363,457 the year before; stocks on hand as of October 30, 1959, were 60,850,337 tons compared with 68,012,807 tons at the same time in 1958; total consumption for the quarter totaled 8,605,064 tons compared with 21,942,077 for the same period in 1958.

△U. S. Dept. of the Interior, Bureau of Mines, reports that consumption of scrap in the United States in December, 1959, totaled 7,021,000 gross tons compared with 4,796,896 tons in November, 1959; consumption of pig iron in December, 1959, totaled 6,911,000 gross tons compared with 3,999,430 tons in November, 1959. Stocks on hand on December 31, 1959, totaled 8,951,000 gross tons of scrap and 2,652,000 tons of pig iron, compared with November 30, 1959, totals: scrap 8,863,911 gross tons, pig iron 2,725,067 gross tons.

△Business and Services Administration, Iron and Steel Div., reports that world steel production in 1959 rose to 318,000,000 tons, compared with output of 289,000,000 tons in 1958.

February 18

△Phoenix Steel Corp. stockholders voted change in debentures allowing mortgage debt limit to go to $55,000,000 from $22,500,000 and the senior debt limit of the corporation to $60,000,000 from $45,000,000.

△The Commerce Dept. reported that personal income in January, 1960, amounted to a seasonally-adjusted annual rate of $393,300,000,000, up $1,200,000,000 from the December, 1959, rate. This compares with the rate of $380,200,000,000 for the year 1959.

△General Electric Co. in 1959 reports sales totaling $4,349,508,529, net profit amounting to $280,242,123 or $3.19 per share compared with 1958 sales amounting to $4,120,769,801, net profit of $242,942,533, and $2.78 per share in 1958.

February 19

△Crucible Steel Co. of America will discontinue hot rolling operations at its Park works June 1, 1960, affecting about 750 employees. Certain finishing and warehousing activities will continue at the works.

△The Bureau of Census, U. S. Dept. of Commerce, reported shipments of iron and steel castings in November, 1959, totaled 999,492 tons compared with 1,052,860 tons in October, 1959, and 1,106,929 tons in November, 1958.

△The U. S. Dept. of Commerce, Bureau of the Census, reports that shipments of steel forgings in December, 1959, totaled 114,424 short tons compared with 87,253 tons in November, 1959, and 112,530 tons in December, 1958; unfilled orders on December 31, 1959, totaled 420,118 tons, compared with 405,210 tons on November 30, 1959, and 313,057 tons on December 31, 1958.

February 22

△The AISI reports that the operating rate of the steel industry for the week of February 22 is scheduled at 2,671,000 tons (93.7 per cent of capacity). This compares with 2,674,000 tons one week ago (93.8 per cent capacity) and 2,506,000 tons one year ago. Index of production for the week is 166.3.

February 23

△Michigan Seamless Tube Co. report for the quarter ended January 31, 1960, shows sales totaling $5,469,098, net earnings totaled $440,807 or 63¢ a share, compared with sales amounting to $4,613,916, net earnings of $420,231 or 60¢ a share in the same period last year.

△U. S. Dept. of Commerce, Bureau of the Census, reports that net shipments of aluminum pig and ingots for December, 1959, totaled 211,695,000 lb compared with 122,966,000 lb in November, 1959, and 98,028,000 lb in December, 1958; net shipments of aluminum mill products in December, 1959, amounted to 268,155,000 lb compared with 247,533,000 lb in November, 1959, and 235,535,000 lb in December, 1958.

February 24

△The Aluminum Assn. reports that production of primary aluminum in the United States for the year 1959 totaled 1,953,019 short tons. Production in January, 1960, amounted to 164,027 tons compared with 156,701 tons in January, 1959.

△Pittsburgh Steel Corp. disclosed it intends to obtain 70 per cent (compared with a present 40 per cent) of its annual requirements of iron ore from company ownership interest mines and has joined U. S. and Canadian companies in developing a 1,000,000,000-ton iron ore deposit in Canada's Quebec Province.

△The annual report of the Mesta Machine Co. shows net income totaling $5,205,801 equal to $5.21 per share in 1959 compared with $6,811,357 net income or $6.81 per share in 1958. Backlog on December 31, 1959, amounted to $71,500,000 compared with $49,400,000 on December 31, 1958.

February 25

△Key grade steelmaking scrap in Pittsburgh dropped $7.00 to $36.00 a ton compared with $46.00 a ton after steel mills resumed production in November.

△The American Iron Ore Assn. and AISI joint report indicates receipts of iron ore and ore agglomerates in the U. S. for the month of December, 1959, totaled 10,942,940 gross tons compared with 3,948,477 tons in December, 1959; stocks on hand as of December 31, 1959, totaled 64,516,011 gross tons compared with 65,841,574 tons as of December 31, 1958; total consumption in December, 1959, was 11,539,231 tons compared with 9,587,958 tons one year ago. Total consumption in 1959 was 94,398,015 gross tons compared with 89,781,164 tons in 1958. There were 224 blast furnaces operating as of December 31, 1959, compared with 192 on December 31, 1958.

February 26

△AISI reported that blast furnaces in the U. S. in January, 1960, produced a record 7,830,097 tons of pig iron and ferroalloys, compared with 7,683,359 tons in December, 1959.

△Algoma Steel starts layoff due to strike called by 74 men operating trains in the yards; strike will result in idling 5500. Strike is called by Brotherhood of Locomotive Firemen and Enginemen over dispute over a new contract.

STEEL COMPANIES FINANCIAL REPORTS—PERIODS ENDING DECEMBER 31, 1959

	Period	1959 net sales	1959 net profit	1959 earnings per share	1958 net sales	1958 net profit	1958 earnings per share
Acme Steel Co.	4th quar.	.....	....	....	.....	....	...
	Year	$ 133,742,903	$ 3,504,135	$ 1.13	$ 124,474,115	$ 5,307,200	$1.89
Alan Wood Steel Co.	4th quar.	22,500,000	1,774,000	2.46	.....	1,231,000	...
	Year	81,100,000	4,865,000	6.63	54,163,265	2,109,203	2.68
Allegheny Ludlum Steel Corp.	4th quar.	49,417,731	2,834,976	0.73	57,364,939	3,317,407	0.86
	Year	230,664,649	11,290,664	2.92	201,715,284	5,844,803	1.52
Armco Steel Corp.	4th quar.	248,759,533	17,403,839	1.17	254,543,104	23,678,809	1.60
	Year	1,043,897,148	76,849,803	5.19	884,423,090	57,512,151	3.89
Atlantic Steel Co.	Year	29,433,860	1,349,526	....	.....	178,375	...
Bethlehem Steel Co.	4th quar.	.....	33,003,943	0.69	529,937,086	57,678,360	1.24
	Year	2,055,720,850	117,235,859	2.44	2,005,937,130	137,741,946	2.91
A. M. Byers Co.	4th quar.	6,666,480	121,000	0.14	5,461,229	275,000	0.26
Carpenter Steel Co.	4th quar.	23,376,614	2,224,479	1.19	16,049,439	894,888	0.49
Ceco Steel Products Corp.	Year	81,666,000	....	2.50	75,295,672	2,052,702	2.05
Colorado Fuel & Iron Corp.	4th quar.	.....	(1,999,729)*	(0.56)	.....	866,788	0.21
	Year	.....	4,364,554	1.04	.....	2,147,223	0.47
Continental Steel Corp.	Year	57,083,835	5,657,052	10.95	46,798,182	3,887,634	7.53
Copperweld Steel Co.	Year	138,364,827	5,972,457	5.00	93,526,153	2,081,114	1.76
Crucible Steel Corp. of America	Year	219,229,062	6,106,443	1.50	186,363,233	4,274,793	1.13
Detroit Steel Corp.	4th quar.	34,724,764	4,226,844	1.38	19,000,000	....	...
	Year	116,712,200	11,939,492	3.90	61,671,996	1,153,692	0.31
Eastern Stainless Steel Corp.	Year	66,900,000	....	$2.15-2.20	49,300,000	....	1.77
Firth Sterling, Inc.	4th quar.	6,187,600	19,100	0.01	4,116,000	(213,800)	...
Granite City Steel Co.	Year	164,371,219	16,142,341	7.53	125,000,000	9,373,580	4.36
Green River Steel Co.	Year	15,708,199	1,350,432	....	6,635,224	(931,157)	...
Inland Steel Co.	Year	713,215,002	48,354,030	2.77	661,253,596	47,869,042	2.77
Interlake Iron Corp.	Year	113,859,000	7,302,000	3.25	83,654,357	2,835,454	1.26
Jessop Steel Co.	Year	33,350,926	1,870,354	2.90	17,871,695	622,461	1.04
Jones & Laughlin Steel Corp.	4th quar.	146,230,000	3,744,000	0.43	191,433,000	10,809,000	1.34
	Year	765,672,000	29,485,000	3.58	654,060,000	23,198,000	2.79
Kaiser Steel Corp.	Year	202,126,940	(7,401,076)	(3.26)	181,385,288	5,422,271	0.76
Keystone Steel & Wire Co.	4th quar.	33,651,303	2,460,693	1.31	26,200,356	1,844,609	0.99
	6 mos.	63,328,889	4,274,257	2.28	49,021,030	3,367,879	1.80
Laclede Steel Co.	4th quar.	.....	....	....	.....	....	...
	Year	.....	5,632,652	....	.....	3,704,251	...
Lone Star Steel Co.	4th quar.	.....	....	....	.....	....	...
	Year	.....	14,175,000	....	.....	1,064,697	...
Lukens Steel Co.	4th quar.	14,363,442	(500,000)	....	25,822,950	644,595	0.67
	Year	83,067,363	2,598,496	2.72	98,896,681	4,181,936	4.38
McLouth Steel Corp.	4th quar.	41,700,000	2,600,000	1.39	58,900,000	4,900,000	...
	Year	176,800,000	10,058,000	5.32	171,361,000	9,998,000	5.18
National Steel Corp.	4th quar.	169,803,514	12,614,652	1.66	158,605,702	14,605,793	1.94
	Year	736,978,650	54,897,360	7.28	539,957,294	35,827,414	4.80
Northwestern Steel and Wire Co.	3 mos. (Jan. 31, 1960)	23,487,655	2,470,852	0.99	16,677,532	1,528,347	0.61
	6 mos.	24,118,092	1,122,784	0.45	34,636,328	2,960,126	1.18
Phoenix Steel Corp.	Year	60,650,000	2,087,390	2.01	27,615,000	(1,967,000)	...
Pittsburgh Steel Co.	4th quar.	29,677,000	(931,000)	(0.80)	40,316,000	959,000	0.40
	Year	149,919,000	(994,000)	(1.45)	133,919,000	(866,000)	(1.37)
Republic Steel Corp.	4th quar.	228,182,014	11,661,805	0.74	281,759,370	22,832,437	0.46
	Year	1,076,832,407	53,890,116	3.43	910,382,817	61,921,680	3.96
Sharon Steel Corp.	Year	119,760,979	2,518,537	2.28	99,970,977	224,942	0.20
Steel Company of Canada, Ltd.	4th quar.	.....	....	....	.....	....	...
	Year	.....	32,878,195	7.58	.....	16,371,019	3.79
United States Pipe & Foundry Co.	Year	119,865,906	10,863,856	2.94	104,656,241	7,142,531	1.94
United States Steel Corp.	4th quar.	748,841,160	30,162,326	0.44	937,081,509	90,728,989	1.57
	Year	3,643,550,009	253,975,686	4.24	3,472,177,091	301,558,231	5.13
Universal-Cyclops Steel Corp.	4th quar.	38,412,835	3,390,324	1.96	26,281,449	1,515,354	0.87
	Year	127,694,091	9,061,057	5.24	84,226,896	3,425,434	1.98
Vanadium Alloys Steel	6 mos.	14,938,917	1,256,932	2.01	10,689,117	616,709	0.99
Washington Steel Corp.	4th quar.	.....	660,850	1.03	.....	488,930	0.79
Woodward Iron Co.	Year	.....	5,486,357	2.13	.....	....	...
Wheeling Steel Corp.	4th quar.	.....	....	....	.....	....	...
	Year	211,634,000	7,033,000	2.53	221,008,000	8,899,000	3.69
Youngstown Sheet and Tube Co.	4th quar.	....	....	....	.....	....	...
	Year	617,889,289	30,956,040	8.90	506,959,574	21,501,320	6.23

* Figures in parentheses indicate losses.

△The AISC reported that shipments of fabricated structural steel in January, 1960, totaled 209,031 tons compared with 224,260 tons in January, 1959; bookings in January, 1960, totaled 221,222 tons compared with 235,784 tons in January, 1959. Backlog as of January 31, 1960, amounted to 2,115,629 tons.

February 29

△Copper prices show decline with dealers offering copper at 35¾ to 36¼¢ lb for delivery first half of March, compared with offering price of 36¾¢ a week ago for delivery in the same period.

△The AISI reports that the operating rate of the steel industry for the week of February 29 is scheduled at 2,654,000 tons (93.1 per cent of capacity). This compares with 2,690,000 tons one week ago (94.4 per cent capacity) and 2,556,000 tons one year ago. Index of production for the week is 165.2.

Bearings, Inc. converts plain bearings to anti-friction bearings... cuts maintenance and lubrication costs... increases production!

Many of our customers have realized considerable savings by converting to anti-friction bearings. Our bearing engineers recommend the best bearings for each type of application, design and supervise production of the special housings often required.

The result is a clean, economical conversion that is quickly installed and materially reduces maintenance and lubricating costs. Production, with better quality, is usually increased.

Ask a BEARINGS, INC. engineer to survey your production machinery. He may be able to suggest and recommend bearings that will increase production at lower cost. Changeovers from plain bearings to anti-friction bearings are a specialty with us.

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and in the South ➤ **DIXIE BEARINGS, INC.**

FLORIDA: Jacksonville • **GEORGIA:** Atlanta • **KENTUCKY:** Louisville • **LOUISIANA:** Baton Rouge • New Orleans **N. CAROLINA:** Charlotte • Greensboro • **S. CAROLINA:** Greenville • **TENNESSEE:** Chattanooga • Kingsport • Knoxville • Nashville **VIRGINIA:** Norfolk • Richmond

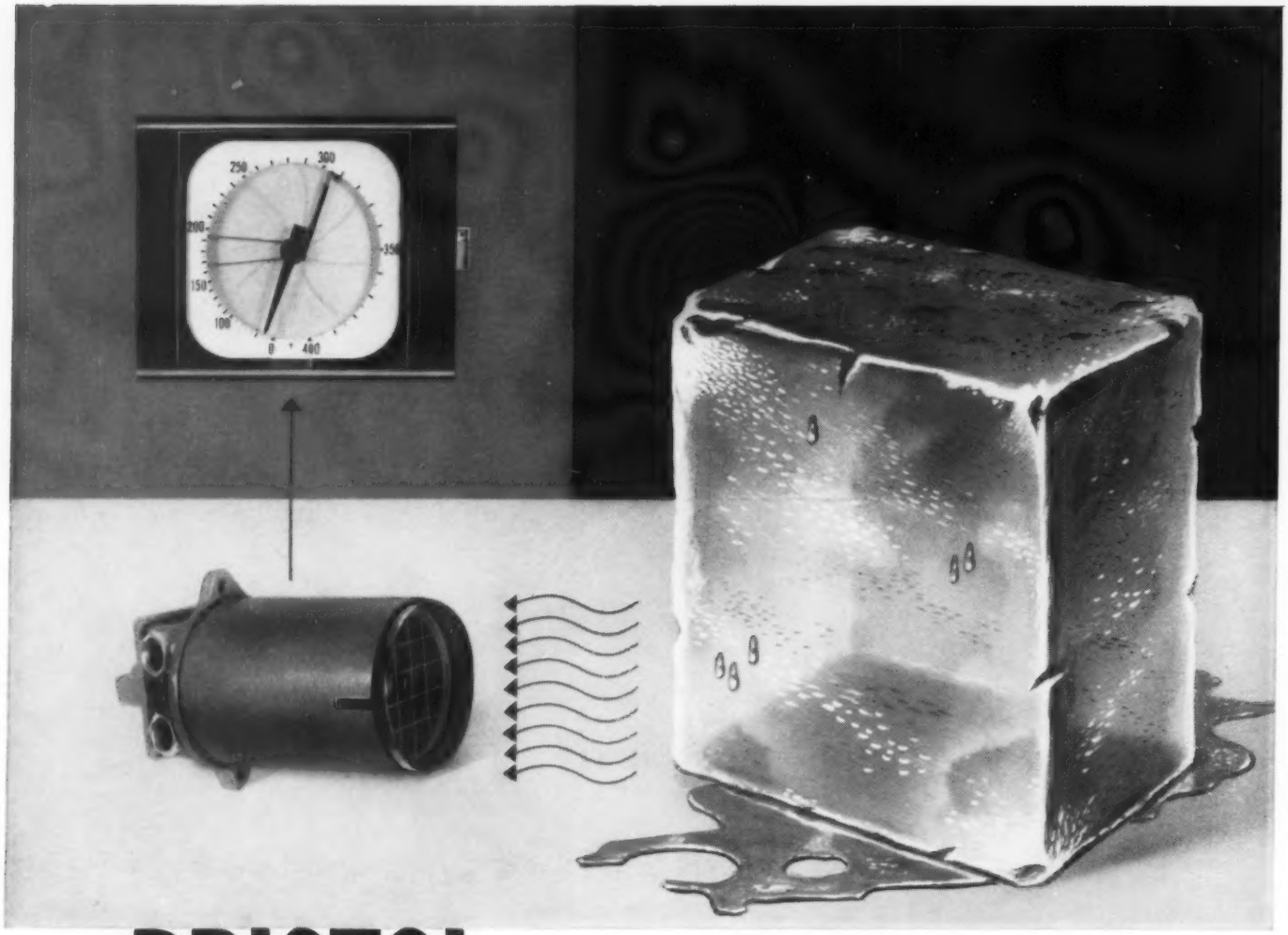
No. 2 Cold Rolled Shearing Line, Cleveland Works, Jones & Laughlin Steel Corporation

Wean, J & L and Shearing . . .

This precision-engineered line was designed by Wean for shearing cold rolled steel strip at the Cleveland Works of Jones & Laughlin Steel Corporation. This cold rolled shearing line handles 60,000 pound coils in strip widths up to 48″ and gauges from .025″ to .060″, producing leveled, oiled sheet from 30″ to 180″ in length. Speeds up to 800 fpm are possible through the use of improved design lapping conveyors on both prime and reject pilers.

Wean is the world's most experienced builder of steel strip processing lines. Our reserve of engineering know-how is always available to assist you in your expansion planning. To meet your customers' most exacting requirements, why not let Wean's *creative engineering* work for *you.*

THE WEAN ENGINEERING COMPANY, INC. • WARREN • OHIO



new BRISTOL low-range radiation pyrometer

IDEAL FOR NO-CONTACT, CONTINUOUS TEMPERATURE MEASUREMENTS ON

Rubber
Synthetic rubber
Tile
Roofing shingles
Adhesives
Blackened or unpolished aluminum
Textiles, synthetic and natural fibres
Paper
Plastics
Carpeting
Mineral aggregates
Chemical flows
Petroleum flows
Beverage flows
Reactor kettles
Mill rolls
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...and many other substances; web processes or products; conveyed, rolled or extruded products; and stationary objects.

0-200° F and other ranges to 1100° F • Direct reading charts, scales in F or C • Calibrated interchangeable head units • Automatic built-in ambient compensation • Easy emissivity compensation

Here's the first radiation pyrometer that really gets down to 0° F.

It's the Bristol Velotron Pyrometer System—so sensitive you can sight the radiation unit (at lower left above) on your hand and get an accurate temperature indication.

And on the high end, spans and ranges are available up to 1100° F or corresponding ranges in degrees Centigrade.

Charts and scales are direct reading, in degrees F or C, even on the lowest ranges. No laborious calibration runs, calculations; no curve consulting needed! And you get famous Bristol Dynamaster* Recorder accuracy —proven in thousands of installations.

Ambient temperature compensation is automatic, completely contained in recorder unit (no third unit needed), and allows use in ambients up to 135° F.

A simple knob adjustment allows compensation for emissivity characteristics of target material from black body on down.

Interconnection cables are standard copper wire; no special, preselected lengths required.

Write for complete technical data on this outstanding new Bristol contribution to industrial pyrometry. The Bristol Company, 123 Bristol Road, Waterbury, Conn. 9.31

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BRISTOL...for improved production through measurement and control

AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS

Field rings were breaking brushes!

NATIONAL stopped brush breakage!

TRADE-MARK

DOWN-TIME COULD HAVE COST THIS POWER COMPANY A FORTUNE!

"RED" BLACKBURN

PROBLEM: Threading and grooving of the steel field rings on giant turbine generators.

RECOMMENDATION: "National" brush grade 634.

RESULTS: This brush eliminated threading, grooving and resisted breakage and chipping when applied to eccentric rings.

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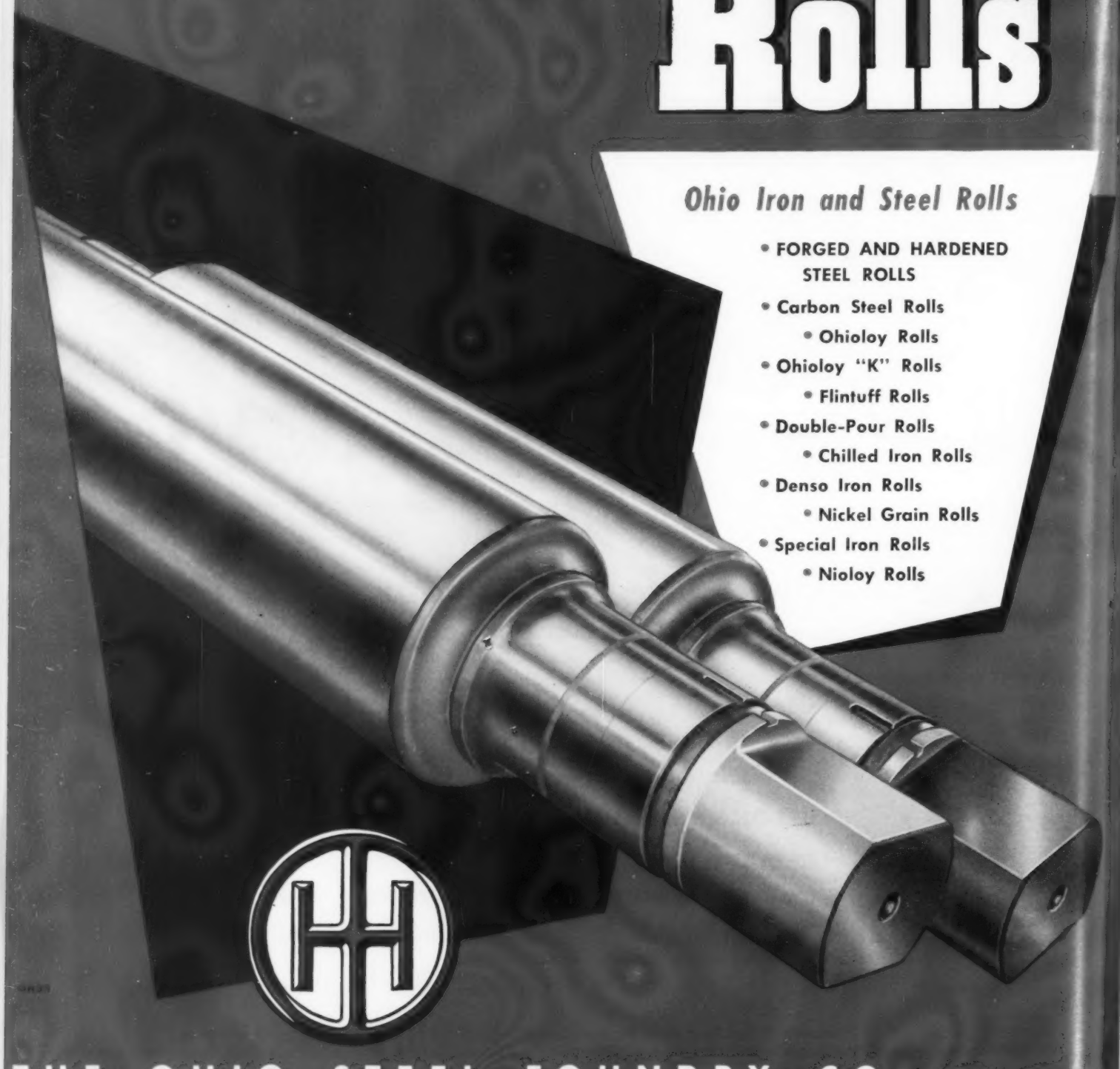
Ohio Rolls

SHAPING METAL FOR ALL INDUSTRY



Ohio Iron and Steel Rolls

- FORGED AND HARDENED STEEL ROLLS
- Carbon Steel Rolls
- Ohioloy Rolls
- Ohioloy "K" Rolls
- Flintuff Rolls
- Double-Pour Rolls
- Chilled Iron Rolls
- Denso Iron Rolls
- Nickel Grain Rolls
- Special Iron Rolls
- Nioloy Rolls

THE OHIO STEEL FOUNDRY CO., LIMA, OHIO

PLANTS AT LIMA AND SPRINGFIELD, OHIO... *Virtually at the center of the steel industry*

Industry News...

IMPROVEMENT PROGRAM ANNOUNCED BY WHEELING STEEL CORP. FOR WEST VIRGINIA FACILITIES

△ Wheeling Steel Corp. has announced a $5,700,000 improvement program for plants and facilities in West Virginia, according to Paul W. Koenemund, vice president in charge of operations. These capital improvements are to be completed this year.

As part of this improvement, immediate steps will be taken to move the equipment and production facilities at the Beech Bottom, W. Va., Works to the Follansbee, W. Va., Department of the Steubenville Works. Operations to be moved include the long terne sheet line and silicon sheet, silicon strip annealing and core plating facilities. The entire move is expected to be completed by late summer.

"Moving the Beech Bottom operations to Follansbee is pointed toward making Wheeling more competitive in the market for electrical steels," Mr. Koenemund said. "The mill facilities and land area to be used at Follansbee were purchased from Follansbee Steel Corp. last year. The Beech Bottom operations to be moved there will be integrated with the Steubenville Works, the basic steelmaking center of Wheeling Steel."

The Steelcrete Factory, adjacent to the Beech Bottom Works, will become a major center for factory and fabricating operations of Wheeling Steel. Initial phases of the expansion and improvement program are already under way at that plant. New installations there will include a continuous 48-in. strip painting line, and a high-speed roll forming and shearing line for the manufacture of roof deck sections.

Other roof deck equipment will be moved from the former Wheeling Factory to the Steelcrete plant. This move will leave the Wheeling Factory empty. A planned program of transfer of operations from that plant was announced in 1956.

The program includes the eventual shutdown of the Ackermann Factory in Wheeling. Mr. Koenemund pointed out that there are two principal reasons for the decision as to the Ackermann plant. "The manufacturers who have been our customers are gradually taking over the production of stampings in their own plants; and, second, our wage rates, pegged at steel mill levels, do not allow us to be competitive in this field."

NATIONAL STEEL AWARDS ADDITIONAL CONTRACTS

△ Awards of additional contracts in the current $300,000,000 expansion program of National Steel Corp. have been announced.

The contracts cover facilities at Great Lakes Steel Corp. in Detroit, Mich., and facilities and buildings at Midwest Steel Corp., in Portage, Ind.

At Great Lakes Steel, an electronic computer control and data logging system for the new 80-in. continuous hot strip mill, currently under construction, will be furnished by Daystrom, Inc.

The computer will provide supervisory control of the numerous adjustments necessary for setting the mill and during operation in order to maintain the close tolerances of order requirements. The computer also will provide for storage of data and recall of pertinent information concerning functions of the mill under varying conditions of operation. This computer installation will be the largest of its kind to be applied to a rolling mill and will result in increased tonnage and improved quality of product.

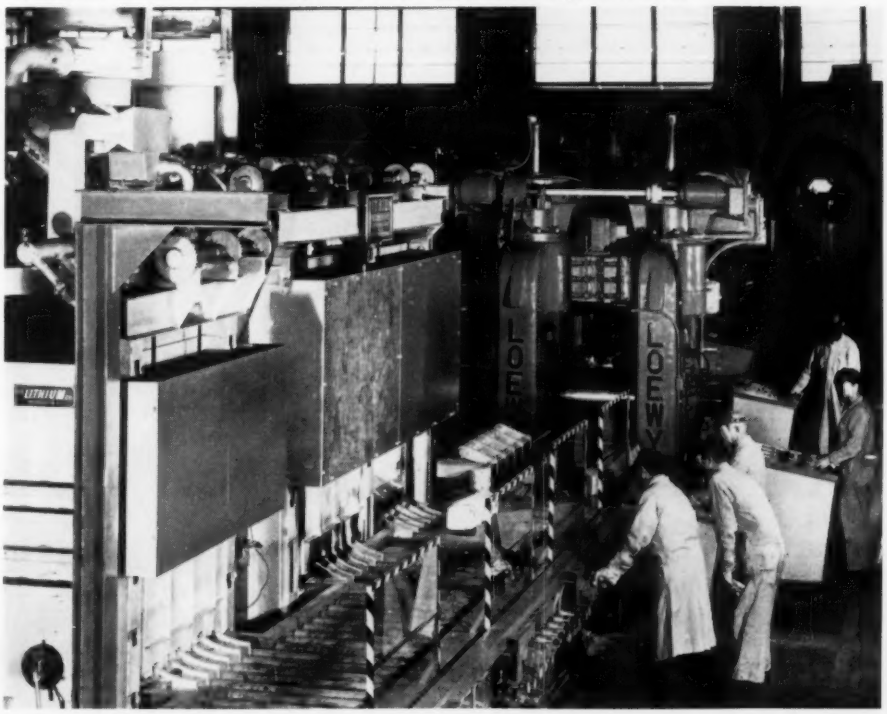
Other contracts covering facilities at Great Lakes Steel are:

Blaw-Knox Co.—General piping for the mill, including the mill

△

MINIATURE ROLLING MILL GOES THROUGH ITS PACES

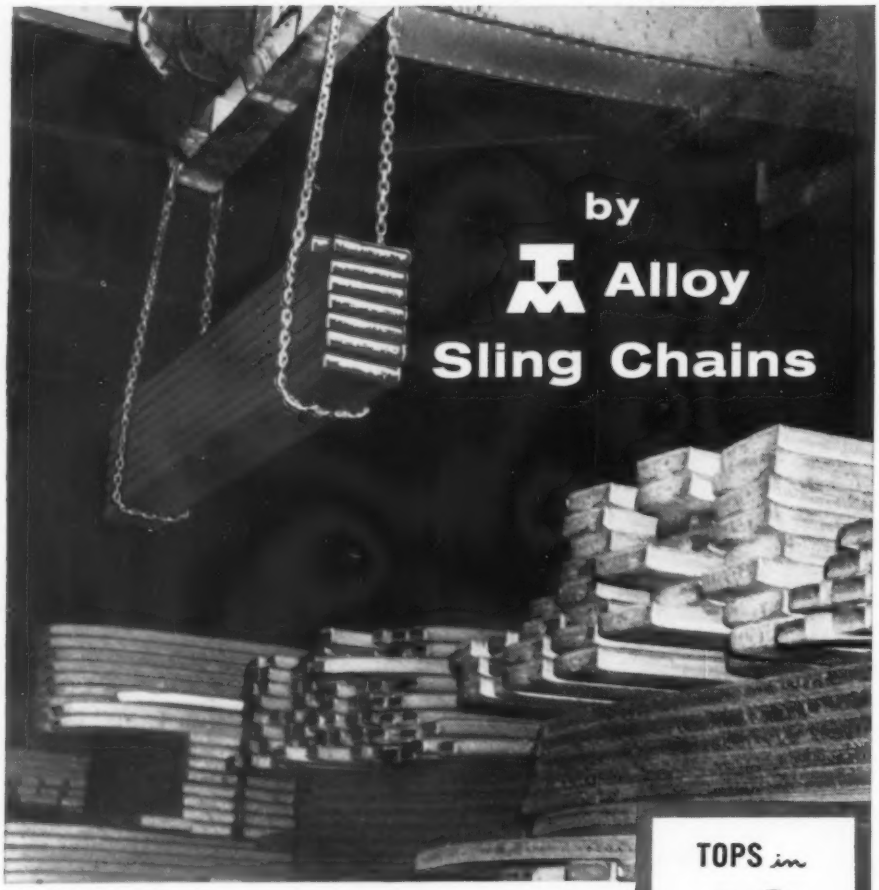
Scientists and technicians at the U. S. Steel's Applied Research Laboratory, Monroeville, Pa., operate what is perhaps the newest and most versatile rolling mill of its size in the world. The miniature mill is almost completely automated and is shown about to roll an experimental steel ingot which has just come from one of the new atmosphere-controlled heating furnaces.



RED-HOT SLABS

handled safely—economically at

ACME STEEL



TM Alloy Chain puts muscle in your safety record. A minimum breaking strain of approximately 125,000 lbs. psi... rugged stress-free links . . . controlled heat-treating are a few reasons why TM Alloy Chain is on the job in industry all over America. Available everywhere from Industrial Distributors, Steel Warehouses and Hardware Wholesalers. Write for Bulletin 14-A — carries complete details.
S. G. TAYLOR CHAIN CO., Inc., Hammond, Ind.

TOPS *in*

STRENGTH

SAFETY

LONG LIFE

Taylor Made CHAIN SINCE 1873

Everything Swings on TM Slings

proper and all services such as air, water, steam, oil, gas, lubrication, etc.; Ingersoll-Rand Co.—Two 3000 cu fpm air compressors complete with 600 hp motors; Farrel-Birmingham Co., Inc.—Three 60 x 240-in. automated roll grinders.

At Midwest Steel Corp., Wean Engineering Co. has been awarded contracts for a Halogen process electrolytic tinning line and an 80-in. continuous raw coil pickle line.

Main electrical equipment for both lines will be furnished by General Electric Co. High-frequency induction strip heating equipment for flow brightening on the tinning line will be furnished by Westinghouse Electric Corp.

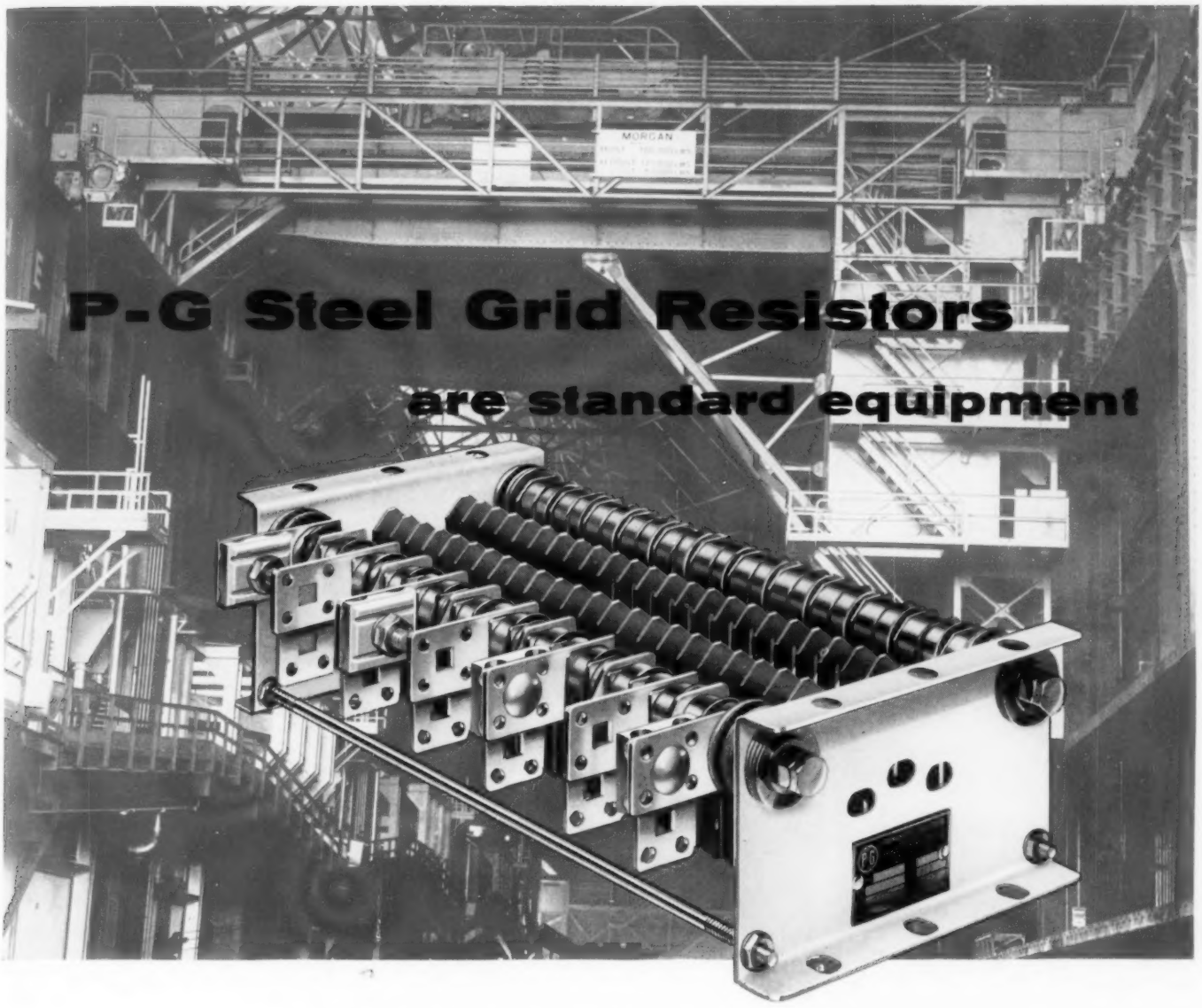
The electrolytic tinning line will operate at 2200 fpm for production of tinplate up to 45 in. wide and in coils weighing up to 90,000 lb. Entry and delivery ends of the line are designed to maintain constant speed in the plating section of the line.

The 80-in. continuous raw coil pickle line is designed for continuous operation of the pickling section at 1250 fpm. The line will be approximately 1075 ft long and will include a cold mill for fracture of mill scale prior to pickling. Blaw-Knox will supply the mill. The pickle line will provide a product width of up to 72 in. in coils weighing up to 90,000 lb.

Westinghouse also has been awarded contracts for the complete electrical equipment for a 52-in. five-stand cold reduction mill furnished by Mesta Machine Co. and for the power distribution equipment for the entire Midwest Steel plant. The latter contract includes all necessary indoor and outdoor substations, switchgear and rectifiers.

Allis - Chalmers Manufacturing Co. has been awarded the contract for complete electrical equipment for a 52-in. two-stand temper mill also being furnished by Mesta.

Boiler contracts at Midwest Steel have been awarded to Babcock and Wilcox Co. for a field erected boiler having a capacity of 280,000 lb of steam per hour and to Erie City Iron Works for a package type boiler having a capacity of 88,000 lb of steam per hour. Both boilers will be equipped for oil and gas firing and will be designed for outside installation.



. . . for Steel Mill Cranes

Over 150 P-G Standard Resistor units are used to control this 350-ton Ladle Crane. These rugged nonbreakable units help keep this large crane in continuous operation. Built of steel and mica, there is nothing to break. P-G Resistors have afforded low cost protection to many steel mill applications for over 25 years. You, too, can obtain this same "Trouble-Free Service" if you specify P-G the ORIGINAL Steel Grid Resistor for your next application. Write for Bulletin No. 500.

The Nonbreakable Steel Grid Resistor

P-G

ESTABLISHED 1892

THE **POST-GLOVER** ELECTRIC COMPANY

OFFICE and FACTORY—Kenton Lands Road, Erlanger, Kentucky

MAILING ADDRESS—Box 709, Covington, Kentucky

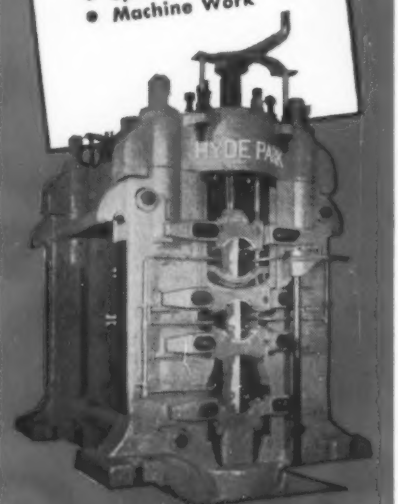
RED CIRCLE Rolls ALLOY-CHILLED

Hyde Park

Rolling Mill Equipment

For more than 50 years Hyde Park Steel Mill equipment has been helping American industry lead the world — equipment such as—

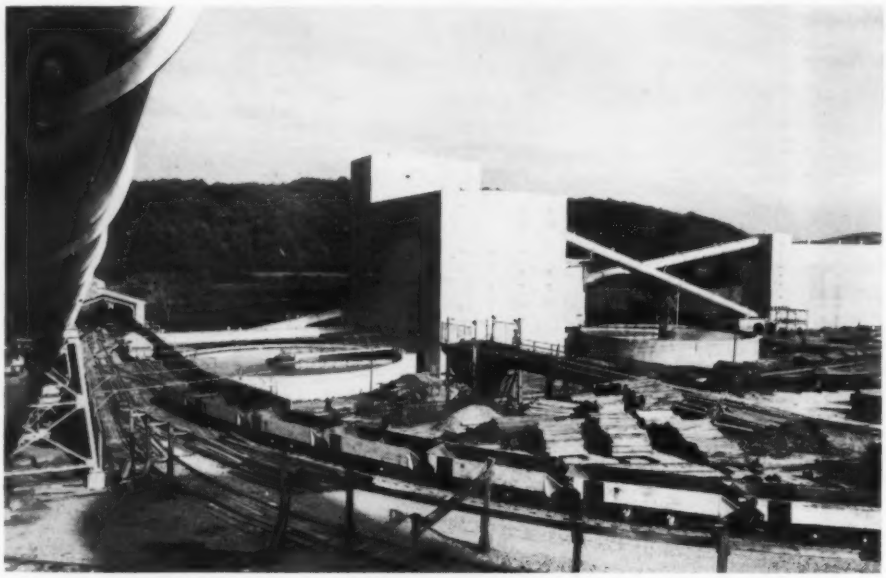
- Bar Mills
- Merchant Mills
- Sheet and Strip Mills
- Pinion Stands
- Roller Tables
- Reduction Drives
- Stretcher Levellers
- Guillotine Shears
- Sheet Mill Shears
- Roll Lathes
- Special Machinery
- Machine Work



For finer finish, long life and greater tonnage, specify Red Circle Rolls.

Hyde Park
FOUNDRY and MACHINE CO.
HYDE PARK
Westmoreland County, Pa.
Rolls
Rolling Mill Equipment
Gray Iron Castings

NEW COAL PREPARATION PLANT IN OPERATION



United States Steel's new coal preparation plant located at U. S. Steel Corp.'s Maple Creek Mine in New Eagle, Pa., represents one of the most modern coal cleaning plants in the world. The new facility is capable of washing coal at the rate of 800 tons per hour when operating at peak capacity. The cleaning plant will process coal from the new Maple Creek Mine and four other U. S. Steel District mines. The processed coal will be transported to the corporation's Clairton Works for conversion into coke.

Contracts covering additional facilities at Midwest Steel are as follows:

Joy Manufacturing Co.—Two 2600 cu fpm air compressors complete with 500 hp motors.

Mesta Machine Co.—Two 60 x 240-in. roll grinders complete with electrical equipment.

Farrel-Birmingham Co., Inc.—Two 36 x 240-in. and one 28 x 192-in. roll grinders complete with electrical equipment.

National Steel Corp.'s expansion program is scheduled for completion in 1962. In addition to the 80-in. hot strip mill and the new finishing plant at Midwest, the program includes construction of oxygen plants at both Great Lakes and Weirton, the addition of 500,000 tons of ingot capacity at Great Lakes, and improvements and additions to tinplate and cold rolled sheet facilities at Weirton.

YAWATA ORDERS DREVER HEAT TREATING LINE

△ The Yawata Iron & Steel Co. of Japan has placed an order with the Drever Co. for a new plate heat treating line. This will be the third line installed in Japan under the direction of Drever, and it will increase the plate heat treating capacity of the Japanese steel industry to about 1300 tons per day.

The line will consist of a hardening furnace, a tempering furnace and a pressure quench with facilities for handling plate up to 50 ft x 142 in. x 3 in. The maximum hardening rate will be 23 tons per hour and the tempering rate 20 tons per hour.

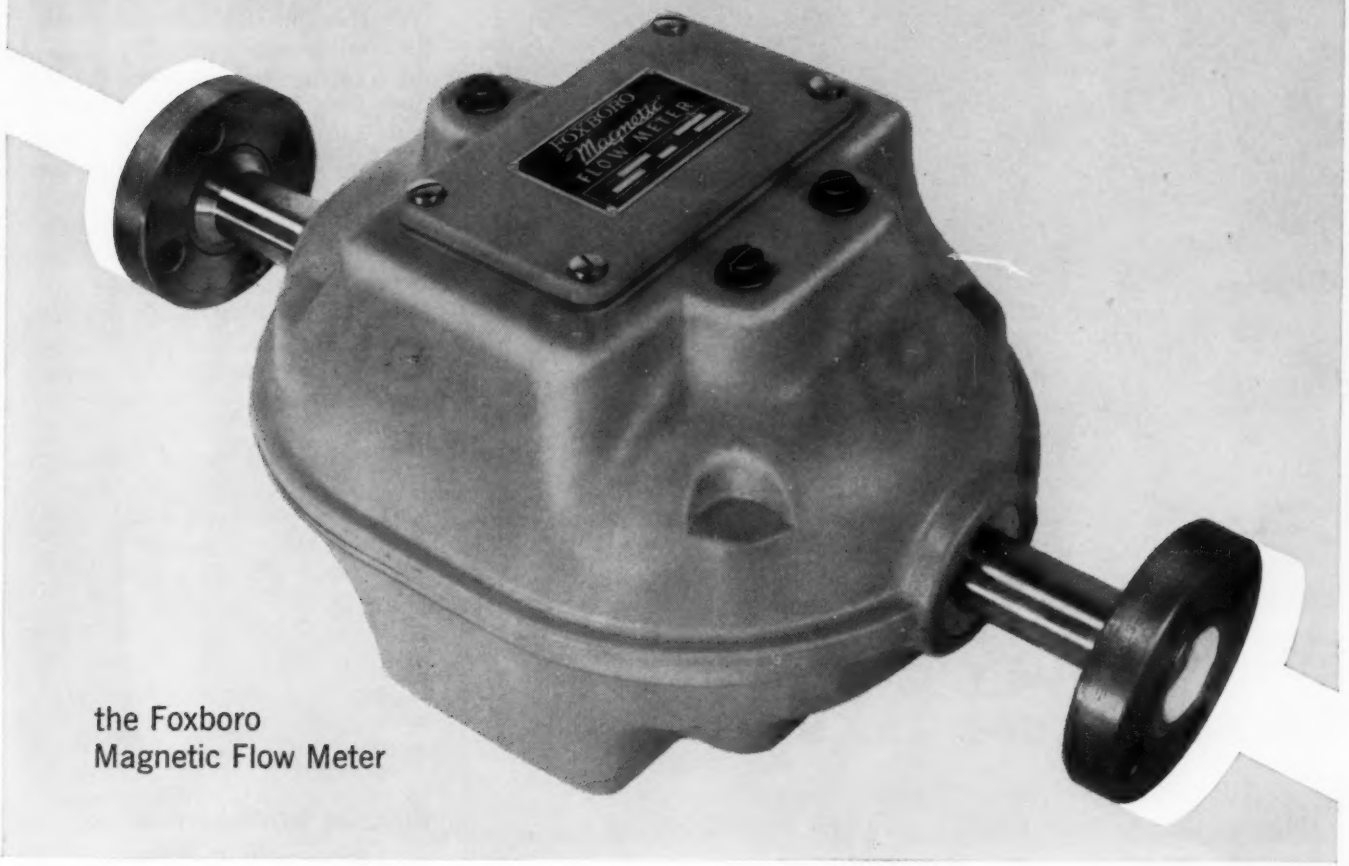
The construction of the line is expected to start this month with operation scheduled for the summer of 1960.

INLAND STEEL ADDING NEW GALVANIZING LINE

△ Inland Steel Co. has announced a 35 per cent expansion of its galvanized steel sheet production capacity. The company will add a fourth continuous galvanizing line to the three already in operation in its Indiana Harbor Works, giving it the largest single-plant capacity in this product in the steel industry.

Construction of the new line is underway with completion scheduled for early 1961. It will coat coils up to 60 in. wide at a rate of 300 fpm and have a rated capacity of

STOPS ACID WASTE IN CONTINUOUS PICKLING!



the Foxboro
Magnetic Flow Meter

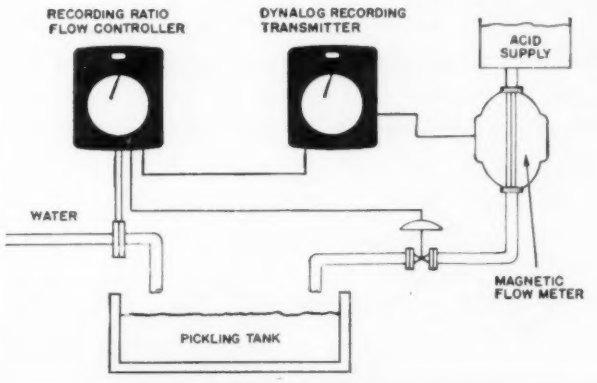
Precise, accurate ratioing of acid-to-water for continuous pickling lines—with no acid wasted. That's the type of control you'll get with a Foxboro Magnetic Flow Meter as the heart of your ratio control system.

Measuring flow of acids and other corrosive liquids is no problem for the Magnetic Flow Meter. This meter has no orifice plate, no pressure taps—no line restrictions of any kind. There's nothing to corrode—nothing to take apart and clean. The meter connects by electric cable to a remote Foxboro Dynalog* Electronic Recorder.

Magnetic Flow Meters install as simply as a length of pipe—operate continuously with an over-all system accuracy of ±1%. Water-acid ratios stay right where you set them. Best of all, waste of acid is completely eliminated.

Ask your nearby Foxboro Field Engineer about the Magnetic Flow Meter, or write today for Bulletin 20-14C, which contains full information. **The Foxboro Company, 583 Neponset Ave., Foxboro, Mass.** *Reg. U.S. Pat. Off.

Typical Water-Acid Ratio System
using a Foxboro Magnetic Flow Meter



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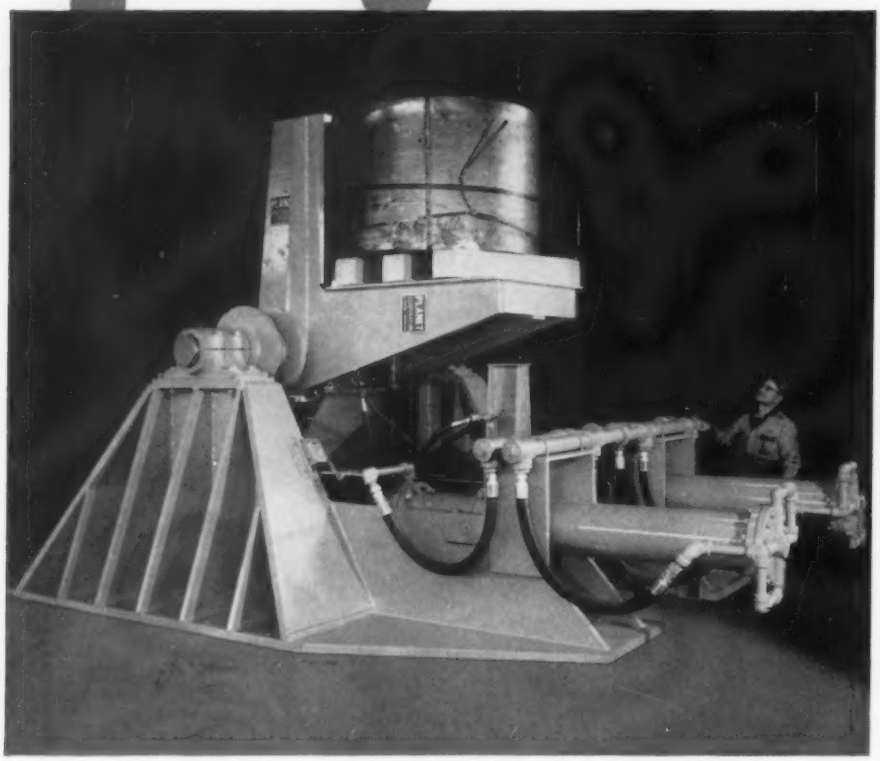
MAGNETIC FLOW METERS

PV
PLANET VERSATILITY...



HEAVY DUTY UPENDER
TURNS 50,000 LB. STEEL COIL

Planet Corporation's Upender is another example of why Planet is known throughout industry as a versatile organization . . . and as an organization which manufactures quality equipment. Planet's Upender turns 50,000 pound coils from a horizontal position to vertical, or vice versa, and it is made to take day in, day out abuse. Although upenders are not unique (as is most of Planet's equipment) it is evidence of Planet's competence in creating and building even the heaviest of materials handling equipment.

PLAN WITH PLANET If your plant has a production, materials handling, or automation problem, let Planet demonstrate how its versatile engineering skill, and production and erection know-how can help you. It has paid many leading industrial concerns whose names are household words to "Plan with Planet" . . . *it will pay you too to use Planet Versatility.* Write or phone today!

PLANET CORPORATION
• ENGINEERED HANDLING SYSTEMS
• AUTOMATION EQUIPMENT
• FOUNDRY HANDLING EQUIPMENT

1816 SUNSET AVENUE
LANSING, MICHIGAN

92

120,000 tons a year. This will lift the company's total capacity for galvanized sheets and coils to 460,000 tons a year.

Supplemental equipment incorporated in the new galvanizing line will permit the substitution of aluminum coating for zinc, the first facilities Inland has had for making aluminized sheets.

Rapid growth in use of the new type galvanized steel produced by the continuous method prompted the company to step up its production, John F. Smith, Jr., president, said. Fabricators are forming galvanized sheets into many finished products which previously had to be made of uncoated steel and then dipped in hot zinc after they were formed.

The zinc coating on the new type sheets will withstand drawing and shaping processes which gives them broad utility in manufactured products.

Inland placed its first continuous galvanizing line in operation in 1951, and added a second in 1954, at which time it discontinued the old process of coating individual sheets by dipping them in pots of molten zinc. It was the first steel company to produce all of its galvanized sheets by the continuous process. Its third line was built in 1955.

WALSH REFRACTORIES APPOINTS DISTRIBUTOR

△ Appointment of Standard Refractories Ltd., Hamilton, Ontario, Canada, as authorized distributor for Walsh Refractories Corp., in the province of Ontario, has been announced.

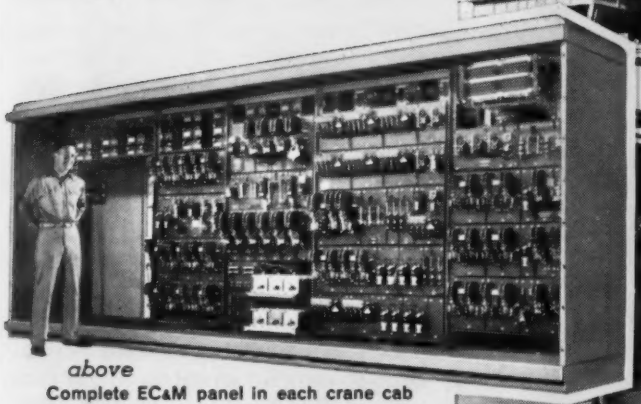
The complete line of Missouri-quality refractories will be handled including fire clay fire brick, air and heat-setting cements, plastic fire brick, ramming mixes and refractory castables.

REPUBLIC TO EXPAND PLASTIC PIPE FACILITIES

△ Plans for the installation of new equipment to expand the production of plastic coated steel pipe at Republic Steel Corp.'s Youngstown, Ohio, plant, were announced.

New facilities costing more than $2,000,000 will be installed to increase the company's X-Tru-Coat

DC PERFORMANCE with AC POWER on these Clyde Cranes



above
Complete EC&M panel in each crane cab provides control of boom hoist, main hoist, quadruplex travel, swing and magnets

at right • View of cab shows VM master switches grouped for operator convenience. EC&M control gives pin-point accuracy required for operation of both cranes in tandem

above • These two 90-ton cranes working in tandem can lift 180 tons, provide the only facility on the Great Lakes capable of handling such a load. The load shown is a 125-ton steel casting

EC&M "HWR" CONTROL does it safer, simpler

EC&M's HWR Controllers provide AC cranes with all the advantages of DC hoist control. Smaller hoist motors can be used than in equivalent AC systems. Moreover, HWR control, with its series motor and brake, provides the simplest and safest operation.

Highly efficient silicon rectifiers (self-contained in the controller) furnish the DC power. Exclusive WRIGHT dynamic lowering circuit combines high-speed handling with accuracy in spotting any load.

HWR controllers are easy to install. On EOT cranes, only four power collectors are needed. Circuitry is simple and the controller is easy to inspect. If you would like DC performance with AC power, check into EC&M's HWR controller.

Get the complete story on HWR controllers. Your Square D Field Engineer can give you the facts, or write Square D Company, EC&M Division, 4500 Lee Road, Cleveland 28, Ohio

SQUARE D COMPANY

EC&M DIVISION • CLEVELAND 28, OHIO

wherever electricity is distributed and controlled

4175

pipe size range to include 6⅝ and 8⅝-in. outside diameter. Previously the largest size available in plastic coated pipe was 5 9/16-in. outside diameter.

The company is accepting orders for the new sizes, with deliveries expected to be made in late spring.

The new coating plant will be located in the north bay of the 10-in. bar mill in Youngstown. Present facilities for plastic coated pipe production at Youngstown also will be moved to the new site. Moving all of the plastic coated pipe facilities into one area will improve production efficiency and provide better delivery schedules. No new buildings will be required in the expansion.

Outstanding feature of the new pipe is that it combines the strength of steel with the protective qualities of plastic thus offering outstanding resistance to corrosion. The coating is extremely tough and is distinguished by a bright yellow color, visible from some distance.

Get larger neck to roll ratios in enclosed designs!

Average thickness of A-B-K bearing = ⅞".

Schematic view of assembly showing higher ratio of neck (A) to roll (B) diameters permitted by use of A-B-K.

use A·B·K* bearings

No need to sacrifice roll neck diameters to keep down size and cost of bearing assemblies and housings. A-B-K bearings save space, permit larger, stronger roll necks—with cheaper, lighter weight parts. A-B-K laminated phenolic bearings have ability to absorb and cushion heavier impacts, and often outwear metal, many times. Grease and oil can be used for lubrication but water, alone, is often the answer. Ask our engineers for specific recommendations.

- Wear longer
- Won't score or heat check
- Light in weight
- Cut lubricant costs
- Save power

A·B·K
LAMINATED
PHENOLIC BEARINGS

*A registered trade-mark of American Brake Shoe Company in the United States and of Joseph Robb & Company, Limited, in Canada.

AMERICAN Brake Shoe COMPANY
AMERICAN BRAKEBLOK DIVISION
P. O. BOX 21, BIRMINGHAM, MICHIGAN

ANNOUNCE NEW GAGE RECORDER FOR STRIP

△ Development of an electromechanical gage recorder, which brings new high standards of efficiency to maintaining edge-to-edge control over gage variations in hot strip steel during 1200 fpm rolling operations, has been reported by the Great Lakes Steel Division of National Steel Corp.

The new equipment makes available in minutes precise inspection data that once took days and weeks to obtain, according to D. H. Dellinger, Great Lakes Steel quality control vice president.

Search for the new device was spurred by discovery that more than normal gage variations in "reject steel" were the result of roll defects and faulty water spray applications going undetected in hot strip rolling operations. This finding pointed up a need for some fast means of expanding upon the end-to-end thickness quality control inspection process being performed by an x-ray gage.

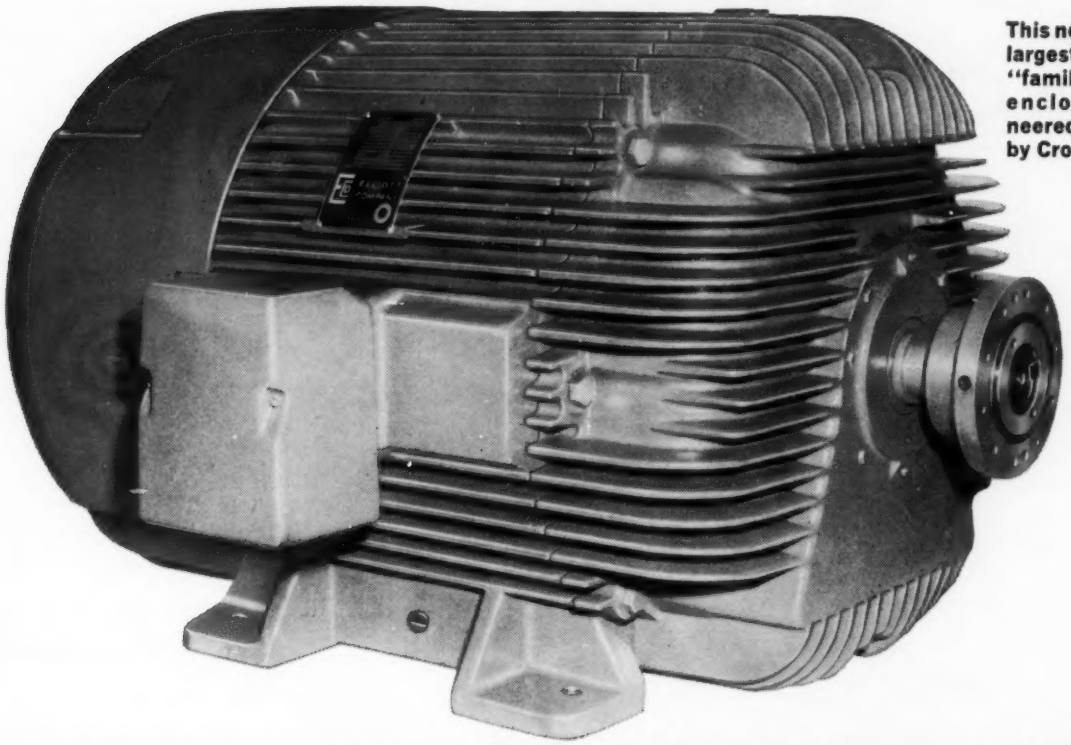
This x-ray gage measures thickness in a single line along the fast rolling steel, but more than normal edge-to-crown variations on the outside of this line were undetectable by the roller operator. To solve the problem involved by cutting out a piece of hot strip and then checking it by hand-micrometer would be too slow, wholly incompatible with the production objectives of a modern strip rolling operation.

In using the newly developed electromechanical gage recorder, the roller operator obtains a four-in., edge-to-edge sample of the hot strip when making a routine surface check. This sample is chilled in water and processed on the portable gage recorder. Within three minutes, the new quality control device automatically graphs any and all gage variations, permitting the roller to immediately take any necessary corrective action.

AMSLER MORTON GIVEN SOAKING PIT CONTRACT

△ Contracts for new soaking pits at the Cleveland Works of Jones & Laughlin Steel Corp. have been

BETTER COOLING MEANS LONGER LIFE LESS MAINTENANCE



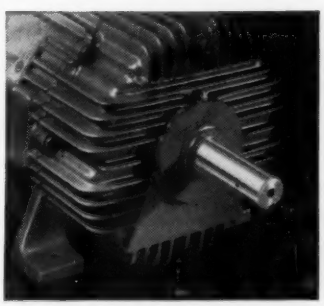
This new 300-hp unit is the largest of the Elliott C-W "family" of ribbed-frame enclosed motors, pioneered in the United States by Crocker-Wheeler.

ELLIOTT C-W SEALEDPOWER MOTORS

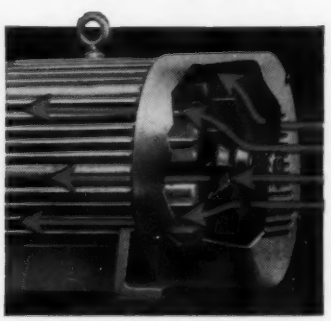
The numerous thin, deep ribs of Elliott C-W SEALEDPOWER Motors are the most advanced development of the ribbed construction, pioneered in the United States by Crocker-Wheeler. Modifications of SEALEDPOWER totally-enclosed fan-cooled motors include explosion-proof designs in all ratings up to 300 hp. Either open greasable or pre-lubricated bearings can be furnished.

Highly-effective sealing prevents entrance of moisture, dust, dirt, corrosive materials; consequently these motors can be depended upon for long, trouble-free service.

In numerous cases, SEALEDPOWER motors are proving to be more economical than standard open motors because of their low maintenance and dependability.



Extra fins keep bearing cool. This potential trouble spot is effectively cooled by the generous extra fins seen in the photograph above.

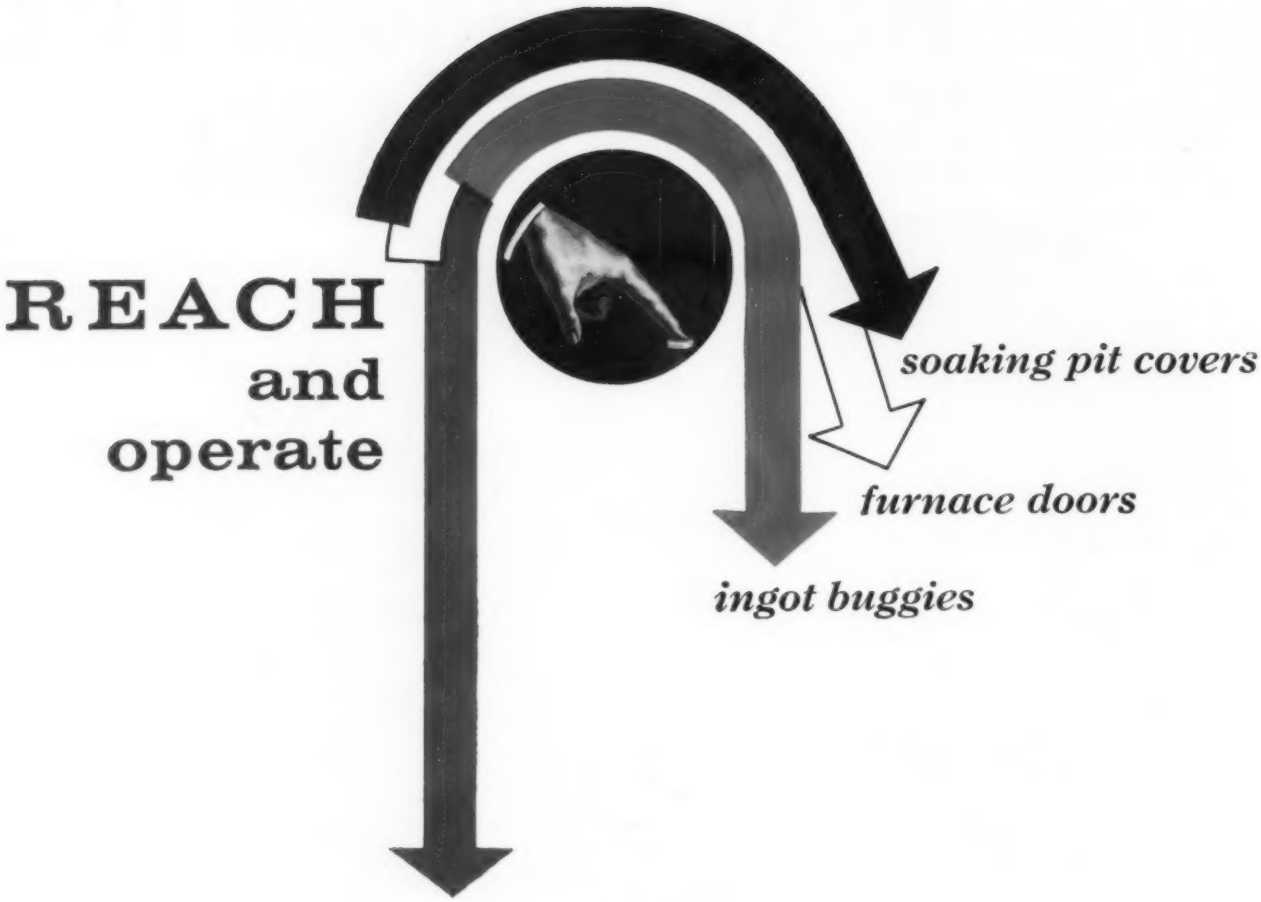


Cooling blast hugs frame. Air is directed along fins extending entire motor length. Easy to clean — no enclosed cooling passages to clog up.

Newest data on modern enclosed motors—including explosion-proof—is given in Elliott Bulletin PB 6000-2. Send for free copy today.

ELLIOTT Company

CROCKER-WHEELER PLANT JEANNETTE, PA.



FROM THE CRANE!

with FEMCO remote control systems

Anything that can be operated from the floor can also be operated *from the crane* with a Femco Remote Control System.

Your cranemen can operate soaking pit covers, open and close furnace doors, position ingot buggies, start and stop conveyor belts, operate upenders. Trippers and hoppers can be operated from ore bridges, cover cranes controlled from an overhead crane, or one overhead crane controlled from another crane.

Hundreds of Femco systems are now in service, performing these and other tasks for steel mills throughout the country, enabling these mills to save time and reduce costs.

These systems require no special wiring—they utilize carrier frequencies transmitted over existing power circuits. They are rugged and dependable, designed and built for the severe conditions of steel mill service. Components plug in for easy replacement . . . any maintenance that may be necessary can be handled by your regular maintenance crews.

We will be glad to discuss the applications of Femco systems in your plant. Just write to Femco, Inc., Irwin, Pa. ▲100

Femco

COMMUNICATIONS: Carrier and wired audio systems for all mining and industrial applications. **MONITORING:** Fans, circuit breakers, valves, pumps, compressors, etc. **TELEMETERING:** Flows, pressures and other functions. **REMOTE CONTROL:** Pumps, valves, circuit breakers, soaking pit covers, furnace doors, cranes, or other moving equipment.

awarded to Amsler Morton Co., Division of Textron Inc.

The new facilities, which will include two rows of two-hole soaking pits, are being installed at a cost of about $900,000 as replacements for obsolete soaking pits. The new soaking pits are of the one-way fired type.

This is the second phase of a soaking pit replacement program at the Cleveland Works. In 1957, J&L put into operation two batteries of four pits and one battery of two pits. These pits are the same size as the new pits—9½ ft wide, 27 ft long and 13½ ft deep. The Works also operates 10 other slightly smaller soaking pits.

The new pits will be equipped with metallic recuperators for heat exchange rather than the tile and metallic style of recuperators formerly used. They are the first of this type to be used by J&L.

All pits will be equipped with automatic controls on fuel-air ratio, furnace pressure and temperature.

The first row is scheduled for completion in three to four months and the second row will be completed shortly thereafter.

PLATE MILL CONTRACT AWARDED TO MESTA

△ Mesta Machine Co. has been awarded a contract covering the design and manufacture of a plate mill installation arranged to operate as either a 160-in. mill or a 210-in. mill. The new facilities will be installed at the Gary Steel Works of United States Steel Corp.

Designed to roll plate from reheated slabs or hot slabs weighing up to 70,000 lb, directly from a slabbing mill, the new installation will include a two-high scale breaking stand, the 160–210-in. four-high reversing plate mill with oil bearings on tapered neck backup rolls, 160 and 210-in. retractable plate levelers and shears. The contract also includes slab handling equipment to and from the reheating furnaces, mill and transfer tables, cooling bed and facilities for disposing of crop and shear scrap.

To arrange the mill for 160 or 210 in. capacity, both housings will be shifted on sliding shoe plates to maintain the same mill centerline. The mill will be powered by two 6000 hp direct drive motors.

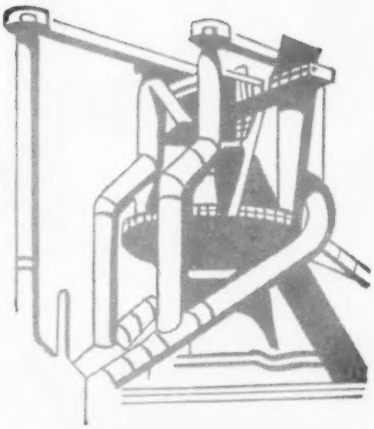
Meetings

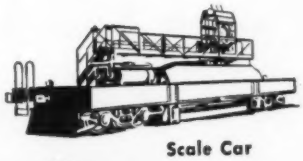
△ The Galvanizers Committee of the steel industry, which is sponsored by the American Zinc Institute, will hold its 41st meeting, April 7–8, at The Chase-Park Plaza Hotels, St. Louis, Mo., concurrently with the annual meeting of the Institute.

△ On Wednesday, April 27, 1960, in Rochester, N. Y., the American Industrial Hygiene Assn. has scheduled a full day's meeting concerned with the industrial noise problem. There will be 13 papers presented at this session covering many facets of the noise problem, including suppression of noise in machine shops, blast furnaces, etc.

Advance registration is recommended for anyone planning to attend. Requests for further information about the conference or advance registration should be directed to Thomas B. Bonney, Chairman, Noise Committee, c/o Aluminum Co. of America, 1501 Alcoa Building, Pittsburgh 19, Pa.

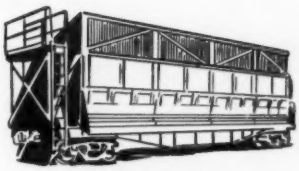
WHEREVER *performance* **COUNTS**





Scale Car

100-ton Ore Transfer Double Compartment, Bottom Dump



Coke Quenching Car

Atlas Cars are built to resist the high wear factors of continuous service handling abrasive materials. Extra factors of safety in brakes, controls, visibility, and signal devices are incorporated for foolproof service.

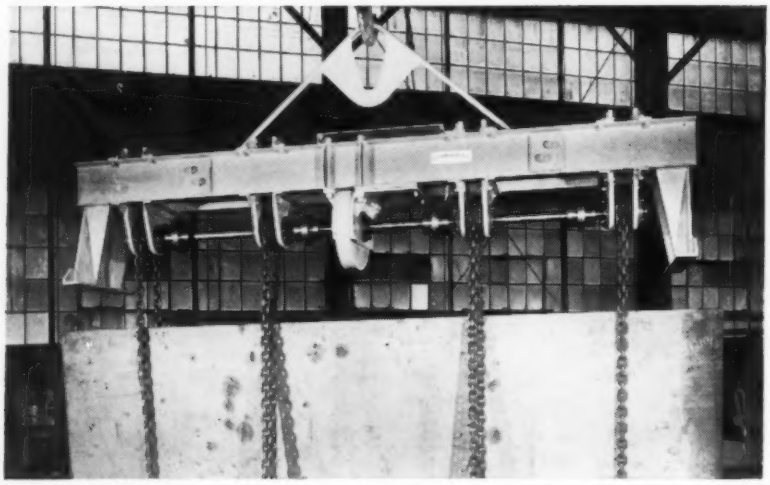
Each car is engineered to meet the operating needs of the plant where it will be used.

ATLAS
CAR & MFG. CO.
1100 IVANHOE ROAD
CLEVELAND 10, OHIO

Consult Atlas for your Steel Plant Cars

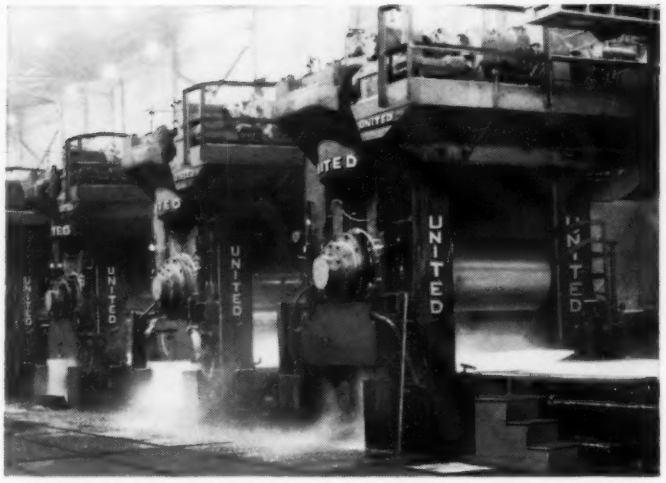
ENGINEERS AND MANUFACTURERS SINCE 1896

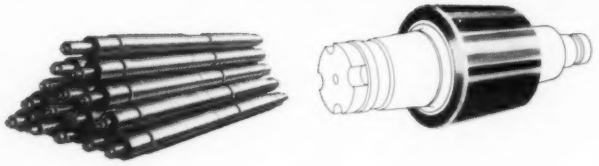
Heppenstall handles it...



Handles it: "If it hangs from a crane, Heppenstall can handle it." Stock tongs are ready for immediate delivery; custom designs are made for special requirements.

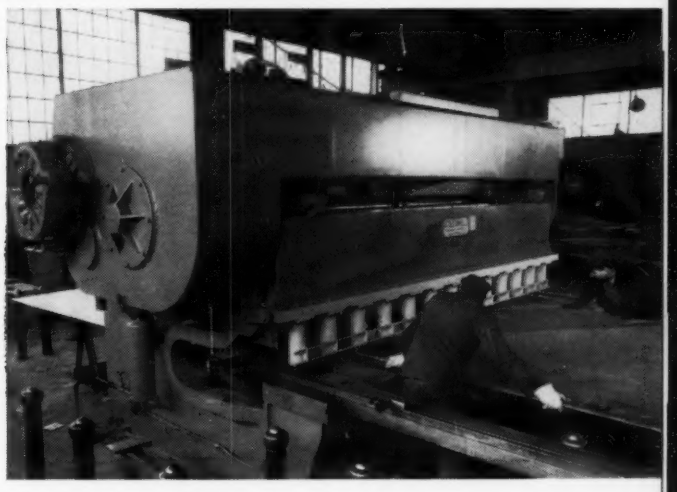
rolls it...





Rolls it: Heppenstall and Midvale-Heppenstall Rolls and Sleeves are made from highest quality alloy steel, thoroughly worked under modern hydraulic presses to obtain maximum density and grain refinement.

cuts it...



Cuts it: A knife is only as good as the steel that's in it. Heppenstall has the variety of electric steel grades to meet the growing need for knife durability at various shearing speeds.

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Die Blocks • Forgings • Back-Up Roll Sleeves Rings • Industrial Knives • Materials Handling Equipment • Pressure Vessels • Hardened and Ground Steel Rolls • Vacuum and Consumable Electrode Melted Steels

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Done hydraulically, with

NORTH AMERICAN EDGE CONTROL

SAVE MONEY!
Reclaim your interleaving paper. Ask about the new paper rewinder with edge control!

No waver, no weaving, no telescoping... North American *ends* tracking problems! Now winding and unwinding goes at top speed with precise tracking—accurate guiding into or from any processing unit!

Built for Men of Steel—rugged as a rolling mill, yet precise as a jeweled watch. North American Edge Control is in three compact units: the detector and the hydraulic relay which operate the power cylinder. Ideal for payoff reels, re-coilers or intermediate steering.

Learn why this unit out-performs any other control method, and at lower cost, too! We invite comparisons, so write now for literature or ask your nearby North American representative.

NORTH AMERICAN for COMBUSTION and Hydraulic Controls

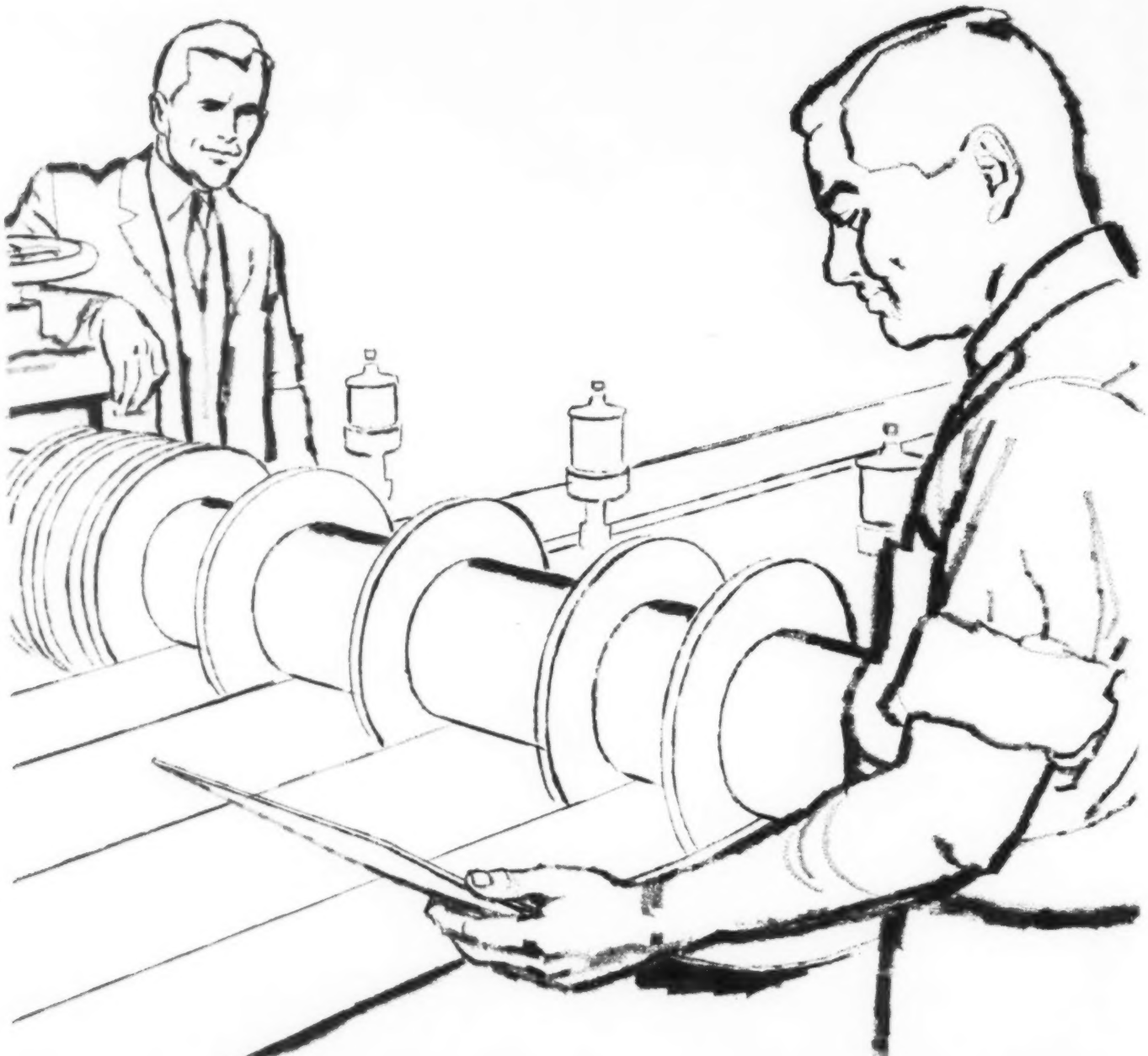
HYDRAULIC CONTROLS DIVISION

The North American Mfg. Co.
Cleveland 5, Ohio

BLAW-KNOX

Blaw-Knox designs and builds a full range of continuous, semicontinuous, and single stand reversing hot strip mills. Other Blaw-Knox equipment for the metals industry includes complete rolling mill installations and auxiliary equipment for ferrous and non-ferrous metals, sheet and strip processing equipment, electrolytic tinning, annealing, and galvanizing lines, seamless pipe and tube mills, draw benches, and cold draw equipment, Blaw-Knox Medart cold finishing equipment, iron, alloy iron and steel rolls, carbon and alloy steel castings, fabricated steel plate or cast-weld design weldments, steel plant equipment, and heat and corrosion resisting alloy castings. Blaw-Knox Company. Foundry and Mill Machinery Division. Blaw-Knox Building, 300 Sixth Avenue, Pittsburgh 22, Pennsylvania.

80-inch continuous hot strip mill



Can you get longer edge life from your SLITTER KNIVES?

A·S·K for the answer!

AMERICAN SHEAR KNIFE

The answer is yes when you use slitter knives from A.S.K. (American Shear Knife Company). A.S.K. Slitter Knives last longer, stand up better under the heaviest jobs, reduce maintenance and replacement costs!

Why? Because A.S.K. has devoted years of research to the selection of proper alloys, and correct techniques in heat treating, precision grinding. For slitter knives that last longer, improve your slitting operation . . . Ask A.S.K.!

FREE HANDBOOK—Want a handy reference on the installation, operation and maintenance of slitter, shear and chipper knives? A.S.K. has the answers in an 88-page manual. For free copy, write American Shear Knife Co., Homestead, Pa.

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MARCH 1960

You Can Obtain . . .

. . . any of the bulletins reviewed in the Publication Service of the IRON AND STEEL ENGINEER without obligation or cost. Simply circle the desired item numbers on one of the prepaid postal cards and mail. The requests will be forwarded to the manufacturers involved who will send the bulletins to you.

Note: Post cards expire three months after publication date.

(1) Dust Collectors

A 16-page brochure describing their line of Series 342 dust collectors is now available from American-Standard Industrial Div. Included in the new bulletin is a list of typical industry applications, itemizing those for power plants, steel production, cement and aggregate production, chemical and petroleum processing, food and grain processing and general manufacturing. A cutaway photo is used to explain operating characteristics, and construction features are described and illustrated. A feature of the bulletin is a pair of nomogram presentations which are designed to simplify engineering calculations relating to Series 342 dust collectors. One nomogram is provided as an aid to quick and accurate collector selection; the other simplifies the determination of anticipated collector efficiency. An example problem is established and carried through to completion as a guide to selection and efficiency determination procedures. (Bulletin 1828)

(2) Taconite Handling

How efficient handling produced a commercially successful method for extracting iron ore from taconite is the subject of a new bulletin offered by the Fuller Co. The operation discussed in this 12-page bulletin is that of the largest taconite pelletizing plant in the Mesabi Range. The story of the system which delivers flint-hard taconite in rocks as large as 60 in. from the mine to the final production of 1-in. pellets of concentrated iron ore is described in detail. Mining processes, conveying techniques, crushing, concentrating and pelletizing operations are fully explained. A series of 19 photographs and three graphic sketches illustrate each phase. Also described are the facilities required to support this operation. An artificial harbor, private railroad line, 150,000 kw power plant and a townsite of more than 800 employee-owned houses are among these facilities. (Fact File ER-33-2)

(3) Speedfax Catalog

Improved readability and added product information are features of the new 1960 Speedfax catalog just published by I-T-E Circuit Breaker Co. The comprehensive 60-page catalog provides information on I-T-E's standard and engineered products in fast-reference form to aid distributors, contractors, engineers and consultants in selecting equipment for industrial plant and commercial building electrical distribution systems. The catalog is divided into three main sections providing extensive information on (1) molded case circuit breakers, (2) individually-enclosed low-voltage power circuit breakers and (3) engineered products. The sections on molded case and low-voltage power circuit breakers provide detailed information on description, prices, selection and application. Selection charts list available types, ratings and accessories. The engineered products section furnishes information on features, ratings for switchgear, primary and secondary unit substations, Tranfo-Units, transformers interrupter switches, power switching centers and other I-T-E engineered products.

A new two-page layout in the Tranfo-Unit portion provides outline sketches and listings of components and ratings for 16 types of Tranfo combinations.

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52	BLISS CO., E. W.	BULLETIN 40-B	Rolling mills
53	BLOOM ENGINEERING CO., INC.		Radiant tube burner
54	BRISTOL CO., THE		Pyrometer
55	CLEVELAND WORM & GEAR DIV., EATON MANUFACTURING CO.	BULLETIN 145	Speed reducers
56	COLUMBUS McKINNON CHAIN CORP.		Alloy chain assembly, care, use and inspection
57	CONE-DRIVE GEARS DIV., MICHIGAN TOOL CO.	BULLETIN CD-218	Hollow shaft speed reducers
58	ELECTRO-ALLOYS DIV., AMERICAN BRAKE SHOE CO.		Thermal fatigue
59	ELLIOTT CO.	BULLETIN PB 6000-2	Sealed power motors
60	EUCLID ELECTRIC & MFG. CO., THE	BULLETIN E-3004	Resistors
61	FARVAL DIV., EATON MANUFACTURING CO.	BULLETIN 26-T BULLETIN 26-S	Centralized lubrication
62	FELLER ENGINEERING CO.	LEAFLET 31/1e	Five-tube tester
63	FOXBORO CO., THE	BULLETIN 20-14C	Magnetic flow meter
64	FRANTZ CO., INC., S. G.	BULLETINS PM-44, HP-44	Magnetic separators
65	GENERAL ELECTRIC CO.		Automation through modernization
66	GENERAL ELECTRIC CO.	BULLETIN GEA-6947	Gage control
67	GENERAL ELECTRIC CO.		Crane controls and wound rotor motor
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69	HAGAN CHEMICALS & CONTROLS, INC.	ITEM M-1	Controllers
70	I-T-E CIRCUIT BREAKER CO.	BULLETIN 4261-2B	Breakers
71	JOHNS-MANVILLE	IN-115A	Insulating fire brick
72	LECTROMELT FURNACE DIV., McGRAW-EDISON CO.	CATALOG 10	Lectromelt furnaces
73	LINK-BELT CO.	BOOK 2764	Bulk handling equipment
74	PENNSYLVANIA CRUSHER DIV., BATH IRON WORKS CORP.	BULLETIN 1040	Hammermills
75	PLIBRICO CO.	CATALOG 69	Plastic refractories
76	POST-GLOVER ELECTRIC CO., THE	BULLETIN NO. 500	Steel grid resistors
77	RAMTITE CO., THE		Refractories
78	RELIANCE ELECTRIC AND ENGINEERING CO.	BULLETIN NO. D-2506	Drives
79	ROCKWELL CO., W. S.	BULLETIN 583	Butterfly valves
80	RUST-OLEUM CORP.		Applications and color systems chart of rust preventive coating
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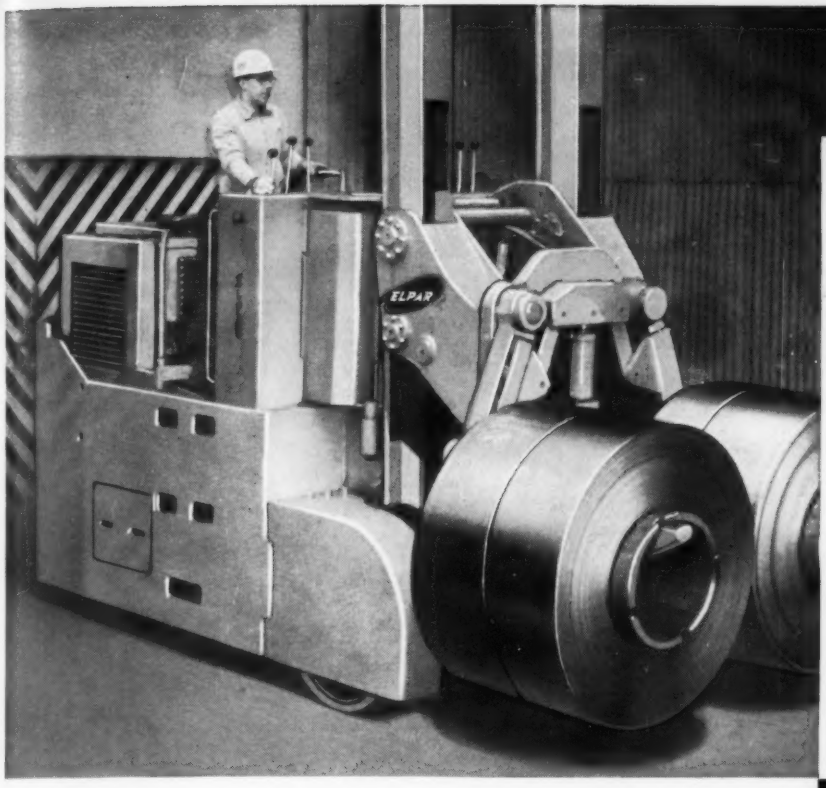
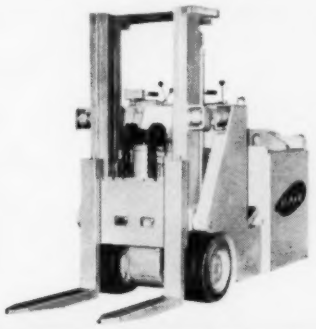
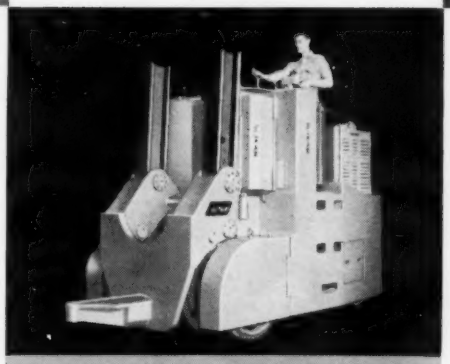
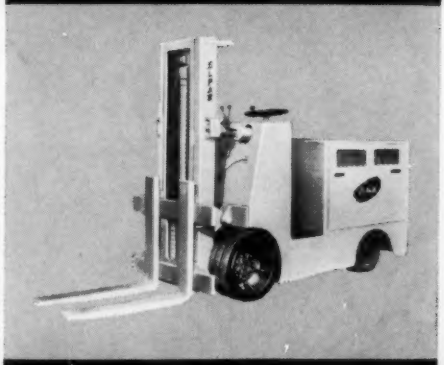


ELPAR

FORK AND RAM TRUCKS







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CAPACITIES FROM 2,000 TO 100,000 LBS.

Metalworking plants — where handling is toughest — demand the kind of rugged trucks that have been an ELPAR specialty for more than 50 years.

Electric power assures dependability and low operating cost. Reduced maintenance . . . space saving economy . . . greater safety . . . easy handling . . . remarkable operating efficiency — are other essential truck features that metalworking plants demand. ELPAR trucks provide them all, plus, a complete line of trucks from the smallest narrow aisle stacker to huge steel handlers.

Ask your local ELPAR man to show you the features of cost-cutting ELPAR trucks built especially for rough service. There's sure to be one that suits your needs exactly.

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TWICE THE LIFE . . . ONE-THIRD THE OPERATING COST

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NBD T-3 ALLOY GUIDES LAST LONGER

Here's an actual case history:

Cast-iron guides .....3 days
No. 1 alloy guides.....4 days
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NBD T-3 ALLOY GUIDES PREVENT COBBLES

T-3 is self polishing. Guides made of the alloy do not pick up steel. The big advantage — cobbles, a common and costly problem of high-speed rod rolling, are eliminated.

NBD T-3 ALLOY GUIDES REDUCE REJECTS

Another major benefit of the self-polishing properties of T-3. Resistance to scale build-up means far fewer guide scratches...far fewer rejects at final rod inspection.

NBD T-3 ALLOY MAY BE WELDED AND MACHINED

Worn guides may be rebuilt with T-3 Alloy rod. The built-up parts are readily machined and have the same excellent wear-resistance and self-polishing properties as the parent T-3 alloy.

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Applied to the operation of a blast furnace, RW-300 digital computer control can result in a 2 to 4 percent increase in production rate or decrease in coke consumption. Measured over a year, such improvements in the return from *one* furnace can equal the investment in an RW-300 system. Similar cost reductions and production increases can be realized through computer control of sintering plants, open-hearth furnaces, oxygen converters, rolling mills, annealing and plating lines, and other processes in existing or new steel mills.

In an effort to boost profits by reducing costs and increasing throughput, many leading steelmakers are now considering computer control, and uppermost in their minds is the question of system reliability proven in the field. More than a dozen RW-300 systems are now operating around the clock in rugged industrial environments.

For further information, call or write Mr. Raymond E. Jacobson, Director of Marketing, Dept. ISE-1076-1.

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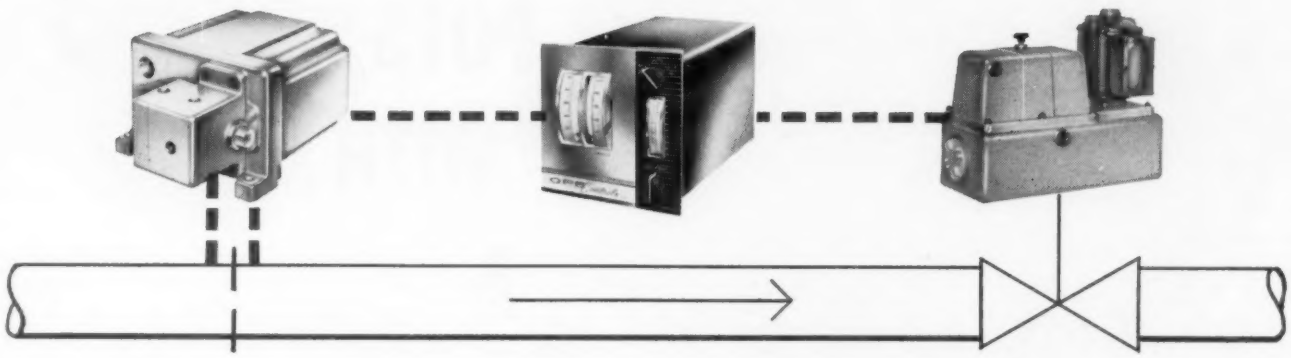

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Personnel News...

G. Findley Griffiths was elected president of Acme Steel Co. He moves up from his post as executive vice president, commercial. Mr. Griffiths joined Acme in 1950 as assistant to the executive vice president and subsequently became assistant to the president in charge of distribution. He was vice president of sales from 1952 until 1958 when he became executive vice president. His career in the steel industry began in 1932 in the New York offices of United States Steel Corp. He served there in various sales capacities for six years. He was with Sharon Steel Co. for eleven years, beginning as a salesman in 1938, was appointed Chicago district manager in 1940; general manager, sales, in 1946; and vice president in 1947.

F. M. Gillies, whose normal retirement date would be at the end of this year, was named chairman of the executive committee of the board of directors. He will serve in that capacity through 1962. He succeeds **Carl J. Sharp,** former president and chairman of the company, who had previously agreed to stay on for two years beyond his retirement date. Mr. Sharp remains as senior consultant to the board until December 31, 1960. **Guy T. Avery,** replaces Mr. Gillies as chairman of the board. Mr. Avery, who would normally have retired last December 31, will continue in his new post until the end of 1961.

Charles C. Morgan has been appointed general manager—operations, for Columbia-Geneva Division of United States Steel Corp. Mr. Morgan has been general superintendent of the division's Geneva Works, near Provo, Utah, since early last year. Mr. Morgan started his steel career as an industrial engineer at the Pittsburg, Calif., plant of the former Columbia Steel Co. in 1939. In 1947 he became superintendent of cold reduction. He was named assistant division superintendent of the sheet and tin mill later that year, superintendent—sheet finishing in 1949, and three years later was promoted to assistant general superintendent of the Pittsburg plant. In 1954, he was transferred to the division's Torrance Works as general superintendent. He returned to Pittsburg as general superintendent in 1957 and assumed that same position at Geneva Works last March.

Louis Moses, mill engineer in the Construction Engineering Department of the Bethlehem Steel Co., retired February 1, after more than 60 years' service in the steel industry. **H. S. Millington** has been appointed to succeed him. Mr. Moses started in 1899 as an office boy at the Cambria Steel Co., Johnstown, Pa. He progressed through the various departments and became superintendent of the Rail Mill and Rolling Department at the Sparrows Point plant of Bethlehem Steel in 1930. Since 1952 he has been mill engineer at the Bethlehem home office. He has been identified as one of the outstanding steel men in roll design and the rolling field. He has contributed much to the AISE, having written many papers, several of which received Kelly Awards. He has been chairman of the Philadelphia section, chairman of the rolling mill division, and served two terms as a director of the AISE.

Dr. Harold T. Clark has been appointed to the newly-created position of administrative director, Research and Development Department, Jones & Laughlin Steel Corp. In his new position, Dr. Clark, who formerly was director of research, will be responsible for supervising general administrative affairs of the department, patent matters, long-range planning of departmental objectives and facilities, and other technical assignments. **Dr. Eric R. Morgan** has been appointed director of research, succeeding Dr. Clark. Dr. Morgan formerly was assistant director of research in charge of metallurgical research. In his new position, he will be responsible for technical direction of J&L research activities.

Hal K. Wilson has been appointed an assistant general manager of the Lackawanna, N. Y., plant of Bethlehem Steel. Co. **James A. Creighton, Jr.,** assistant superintendent of the 79-in. continuous sheet, strip and plate mills, was appointed superintendent to succeed Mr. Wilson. **George R. Sackerson,** superintendent of the blooming mills, was advanced to succeed Mr. Creighton

G. F. GRIFFITHS

C. C. MORGAN

LOUIS MOSES

DR. H. T. CLARK

H. K. WILSON

J. A. CREIGHTON, JR.

G. R. SACKERSON

H. A. RICHARDS

and **Howard E. Hattal** was appointed to Mr. Sackerson's former post. **Fenton B. Sparrow** succeeds Mr. Hattal as assistant superintendent of structural mills and the structural shipping yard, and **Thomas J. Dugan, Jr.,** succeeds Mr. Sparrow as assistant superintendent of the 44-in. blooming mill and 32-in. rail mill.

Mr. Wilson was enrolled in the Bethlehem Steel loop course in 1924. He worked at Bethlehem's Johnstown plant for three years. Later he became a mechanical foreman at the Lackawanna Plant, serving in the Blast Furnace and Strip Mill Departments. From the capacity of assistant superintendent he was promoted to superintendent of the Mechanical Department in 1944 and of the strip mills division in 1945. Mr. Creighton joined Bethlehem's loop course in 1946 and was assigned to the Lackawanna strip mill as an engineer. In 1951 he was appointed assistant superintendent of the cold strip mill. He was named assistant to superintendent of the strip mills division in 1953 and assistant superintendent in 1955. Mr. Sakerson was a member of the 1939 loop course. He joined the Mills Department of Lackawanna and was appointed an assistant superintendent in 1947. After serving in several assignments he was appointed to blooming mills superintendent in 1952. Mr. Hattal started with Lackawanna in the mills division and was appointed assistant to superintendent in 1952. In 1959 he became assistant superintendent of the structural mills and structural shipping yard. Mr. Sparrow started as a looper at Lackawanna in 1951. He became a turn foreman in 1956 and assistant superintendent of the 44-in. bloomer and 32-in. rail mill in 1959. Mr. Dugan joined the Bethlehem loop course in 1956 and started with Lackawanna in 1957 as an engineer in the mills division.

Harry A. Richards has been named manager of raw materials at Weirton Steel Co. division of National Steel Corp. to succeed **Thomas J. Hudson** who has retired. Mr. Hudson, a veteran of more than 44 years of service, had been manager of raw materials since 1939. Mr. Richards had been assistant manager of raw materials since July 1, 1959.

Roger M. Wolcott has been appointed to the newly-created position of assistant director—production planning programs, Jones & Laughlin Steel Corp. He formerly was assistant to the vice president—engineering and plant. **Walter L. Moore** has been named to the new position of co-ordinator—production planning control procedures. He formerly was assistant superintendent of production planning at J&L's Pittsburgh Works.

Mr. Wolcott has been a J&L employee since 1938, when he started as a trainee. He became a practice engineer at Pittsburgh Works in 1939. He since has held positions as special assistant to the works manager; assistant superintendent, Open Hearth Department; superintendent, Open Hearth Department; all at Pittsburgh Works; and assistant works manager—project development, Cleveland Works. He was named assistant to the vice president—Engineering and Plant last year. Mr. Moore started with J&L in 1951 as an accounting trainee in the general office. He was named a staff assistant, systems and procedures section in 1952. He has been assistant superintendent of production planning at Pittsburgh Works since 1958.

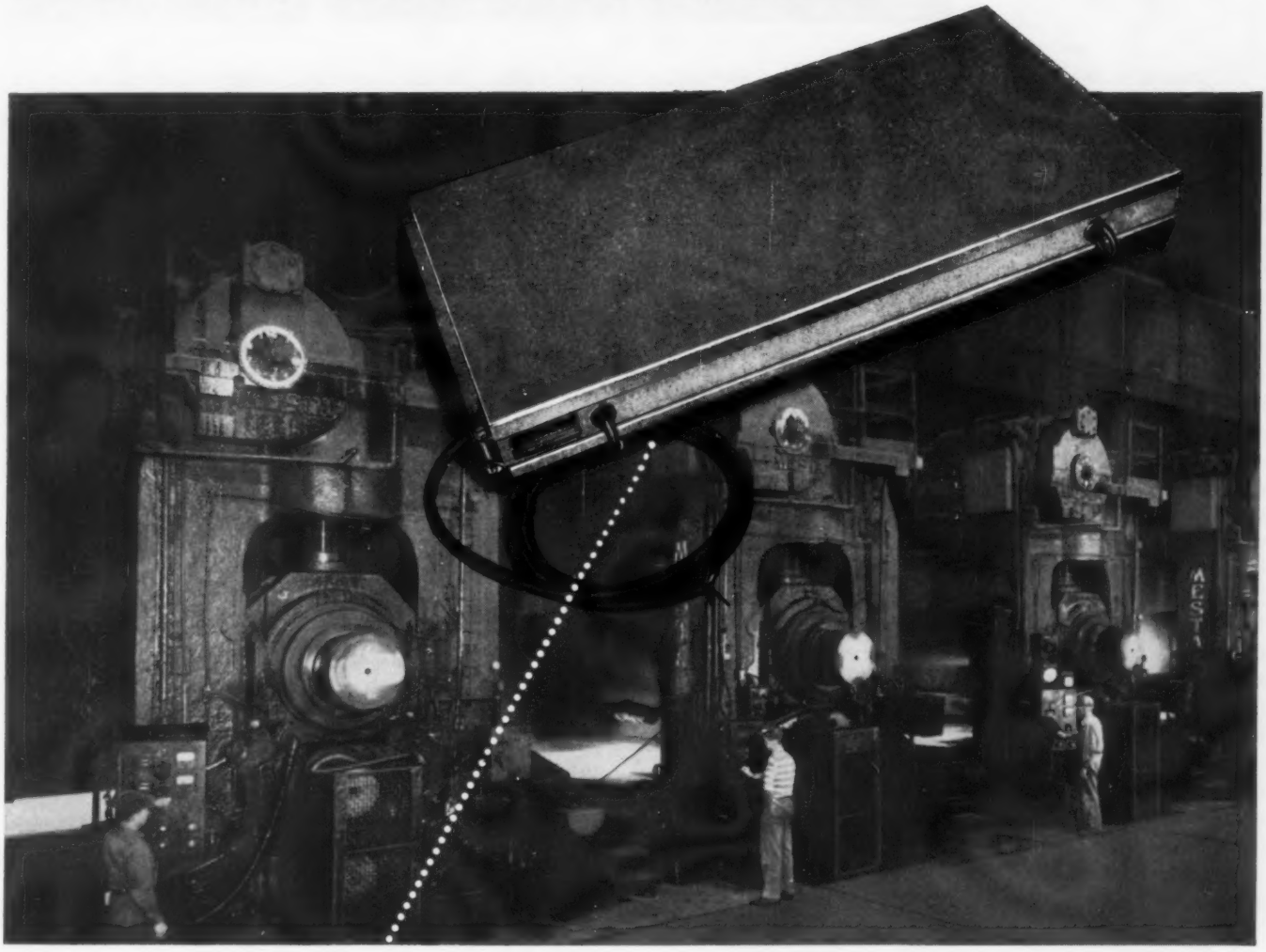
Leonard Larson, formerly chief engineer of the Cleveland, Ohio, plant of Republic Steel Corp., has been named chief engineer in charge of flat rolled products for Republic. Mr. Larson had headed the Engineering Department at the plant for the past 21 years. For the preceding 10 years he had been chief engineer of the Central Alloy district of Republic with headquarters at Massillon, Ohio, with the exception of two years, from 1933 to 1935, when he was divisional superintendent of the Massillon plant. He began working in the steel industry in 1912 and in 1917 came to the Central Steel Co., a predecessor company of Republic Steel, as a draftsman.

Roy W. Kroeger succeeds Mr. Larson as chief engineer of the Cleveland plant. Mr. Kroeger has been with Republic for the past 24 years and had been assistant chief engineer since 1951.

LEONARD LARSON

R. W. KROEGER

ASEA Pressductors are the heart of the Automatic Gage Control System for hot strip mill at Geneva Works, United States Steel Corporation, Provo, Utah.



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R. W. SUNDQUIST (left)

J. V. DORMAN (center)

E. C. SORRELLS (right)

Raymond W. Sundquist, John V. Dorman and **Everett C. Sorrells** have been appointed assistant general superintendents at U. S. Steel Corp.'s Gary, Ind., works. Mr. Sundquist, who will be in charge of coke, iron and steel production, joined the Gary Works Blast Furnace Department in 1938. He was promoted to assistant to superintendent—blast furnaces, and assistant superintendent—blast furnaces, both in 1943; superintendent of blast furnaces, 1947; assistant division superintendent—blast furnaces in 1950, and to his last position, division superintendent of blast furnaces, 1954. Mr. Dorman, who will be in charge of rolling and finishing. joined U. S. Steel as a metallurgical observer at Homestead Works in 1934. Moving to the Structural Division of the plant in 1936, he advanced to assistant division superintendent before receiving an appointment as assistant to general superintendent in 1949. Mr. Dorman was named division superintendent—power and fuel in 1950, division superintendent—central maintenance in 1955, and division superintendent—slab and plate in 1958. Mr. Sorrells, who is in charge of services, began employment with U. S. Steel at Gary Works in 1936, subsequently becoming chief metallurgical observer in the Open Hearth Department in 1944. In a series of promotions he advanced to assistant superintendent, open hearth shop No. 5 in 1950, and superintendent of the shop the following year. In 1952 Mr. Sorrells was named assistant division superintendent—steel production and the next year division superintendent. He was named to his last post, assistant to the general superintendent of the plant, in 1956.

J. A. Bruce Pinney was named assistant chief engineer of Alan Wood Steel Co. Mr. Pinney will be responsible for all of the company's major expansion projects. In addition, the company has announced the promotion of **Elmer V. Eisenberger** to electrical engineer from assistant electrical engineer. Mr. Pinney joined Alan Wood as an electrical design engineer in 1951 and was made assistant electrical engineer in 1953. Mr. Eisenberger was employed as electrical design engineer by the B. F. Goodrich Co. until last year when he joined Alan Wood as an assistant electrical engineer.

Charles W. Finkl has been elected vice president of operations and engineering of A. Finkl & Sons Co. He was previously in charge of engineering and research, which will continue to come under his direction.

Joseph F. Byrne was named assistant director of purchases for National Tube Division, United States Steel Corp. He has been project purchasing agent for Columbia-Geneva Division in San Francisco since 1954. Mr. Byrne will succeed **John J. Hepler,** who has been named assistant to the vice president—purchases of U. S. Steel.

Thomas F. Cleary has retired as chief inspector-quality control in the Tin Mill Department of Weirton Steel Co., division of National Steel Corp. Mr. Cleary is succeeded by **E. A. Starr,** who had been assistant chief inspector. Mr. Cleary was a Weirton employee for more than 32 years and had been chief inspector in the Tin Mill since 1948. Mr. Starr is a 13-year employee and had been assistant chief inspector for the past 12 years.

E. O. Austermiller, National Tube Division, United States Steel Corp., National Works, has retired as of February 1, 1960, after 16 years of service as chief engineer.

Edwin E. Brinkerhoff was appointed to the newly-created position of chief combustion engineer for Republic Steel Corp.'s Central Alloy District. A veteran of 21 years with Republic, Mr. Brinkerhoff has been chief combustion engineer at Republic's Massillon, Ohio, plant since 1955. Prior to that time, he had been assistant chief combustion engineer for 14 years. He started at Republic in 1938, as a chemist, and later was employed two years as a meter man. From 1934 until joining Republic, he was employed with the Empire Steel Co. in Mansfield, Ohio.

Nelson W. Hocking, Jr., has been appointed superintendent of maintenance at Wheeling Steel Corp.'s Steubenville Works. Mr. Hocking joined Wheeling Steel in 1949 as a practice engineer at Steubenville. Prior to

E. E. BRINKERHOFF

N. W. HOCKING, JR.

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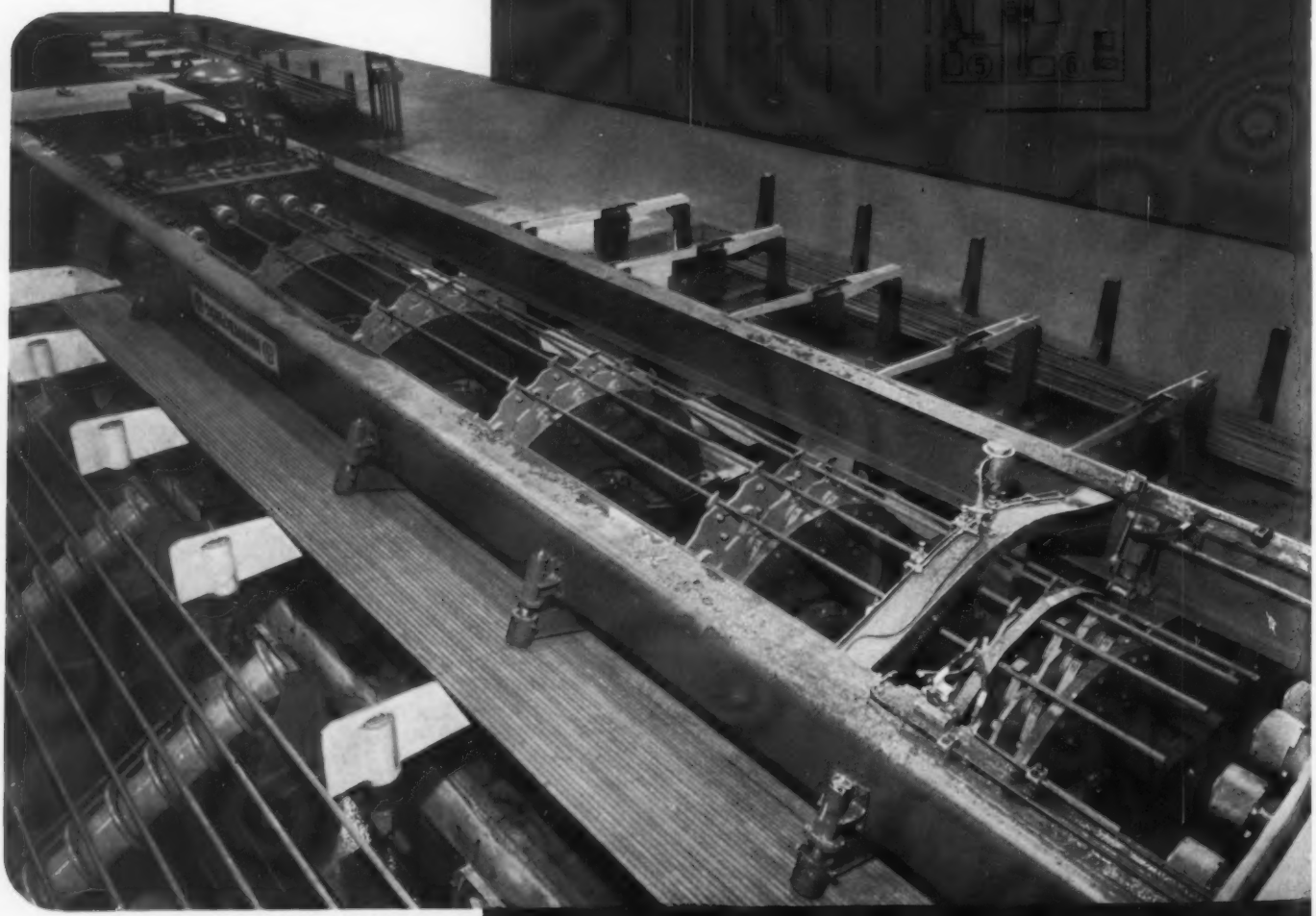

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Tubes of varying lengths and diameters can be tested automatically on SCHLOEMANN's new five-tube tester. Two standard models are available – one for tubes 1/2 in. to 2 in. i.d., 17 ft. to 25 ft. long and another for tubes up to 4 in. i.d. and 50 ft. in length. Special design permits rapid change-over to different tube sizes. Maximum testing pressure 1,500 PSI (25 ft. model), 2,300 PSI (50 ft. model). – Electro-hydraulic pre-set controls. *For further details send for leaflet 31/1e.*

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his recent promotion, he was chief plant engineer at the company's Yorkville Works.

E. Walter Adams has been appointed manager of operations, Eastern area plant, Kaiser Refractories & Chemicals Division, and **Carey E. Lindsay** has been named production manager for these facilities. Mr. Adams has been serving as plant manager of the company's basic refractories plant at Columbiana, Ohio, a position he has held since the plant was built in 1955. Mr. Lindsay was formerly general superintendent of the clay and silica refractories plants at Niles, Ohio; Frostburg, Md.; and Van Dyke, Pa., of the Mexico Refractories Co.

Fred B. O'Mara has been named director of manufacturing for National Carbon Co., Division of Union Carbide Corp. Mr. O'Mara joined National Carbon in 1936. He served in the production organization until 1944, when he became associated with the Marketing Department. His most recent assignment was as marketing manager of electrode products.

James F. Young has been named general manager—electric utility systems engineering and planning operation, General Electric Co., in the company's newly formed electric utility group. **Dr. J. Herbert Hollomon** succeeds Mr. Young as general manager of the general engineering laboratory.

A. J. Parke, Jr., has been appointed superintendent of the Open Hearth Department at the Pittsburgh Works of Jones & Laughlin Steel Corp. He was formerly assistant superintendent. **Daniel R. Loughrey** has been appointed to the newly-created position of consultant to the superintendent, Pittsburgh Works Open Hearth Department. **John F. Pollack** succeeds Mr. Loughrey as coordinator of steelmaking operations. He formerly was superintendent of the Open Hearth Department. Mr. Parke started with J&L in 1957, as general turn foreman at the Open Hearth Department. He had been an employee of Bethlehem Steel Co. for seven years, the last four as an open hearth melter. He was appointed assistant superintendent of the Pittsburgh Works Open Hearth Department in 1959. Mr. Loughrey started at J&L's Pittsburgh Works in 1922, as foreman, steel works metallurgical inspectors, and, in 1923, was named turn foreman and assistant superintendent, Bessemer Department. He became superintendent of the Bessemer Department in 1929, and superintendent of the Pittsburgh Works Open Hearth and Bessemer Department in 1948. He was transferred to J&L's general office in 1953, and appointed coordinator of steelmaking operations in 1956. Mr. Pollack started in 1937, as a metallurgical inspector in the Open Hearth Department at the Aliquippa Works, and, after a short period as a metallurgist at J&L's research laboratory, became the open hearth metallurgist at Pittsburgh Works. He was named steel works metallurgist at Pittsburgh in 1943, and assistant superintendent—special, open hearth in 1949. He was appointed assistant to the open hearth superintendent in 1951; assistant superintendent in 1953; and superintendent of the department in 1955.

C. A. Anderson has been named superintendent of the Blast Furnace Department at Republic Steel Corp.'s Youngstown, Ohio, plant. He succeeds **Ernest Wilson** who has retired. Mr. Anderson started his career at Republic's plant in Buffalo, N. Y., as a welder in the Maintenance Department. He held a number of other positions in Buffalo and subsequently was made assistant superintendent of the Blast Furnace Department early last year. He was transferred to Youngstown in a similar position in May, 1959.

Herbert P. Canerdy has retired as sales manager, The Robinson Ventilating Co., following twenty-five years of service.

Earl V. Akerlow has been appointed contract manager for a management agreement between Koppers Co., Inc., and Acerias Paz del Rio, S. A., an integrated steel firm with headquarters in Bogota, Columbia. In his new position, Mr. Akerlow will co-ordinate all Koppers activities in fulfilling the agreement. The agreement provides that Koppers furnish Acerias Paz del Rio with technical and management assistance in connection with Acerias' operations, organization, production facilities and extension of such facilities. For the past 15 years Mr. Akerlow was affiliated in various capacities with Henry J. Kaiser Co. He was manager of the Steel Division during the recently completed Fontana plant expansion.

Robert R. Digby has been appointed executive vice president of Roy C. Clark, Inc. Mr. Digby was formerly sales manager of the Eichleay Corp.

Earl W. Mahaney, formerly chief metallurgist, has been named superintendent of the new Quality Control Department, Indiana Harbor Works, the Youngstown

A. J. PARKE, JR.

D. R. LOUGHREY

J. F. POLLACK

C. A. ANDERSON

E. W. MAHANEY

L. R. LAUX

A. C. VEREL

W. B. WALLIS

Sheet & Tube Co. Two additional superintendents were appointed as a result of the change: **Emmett E. Holmgren,** formerly chief inspector, was appointed superintendent of Steel Plant, Quality Control; and **Joseph J. Wolf,** formerly division metallurgist, flat rolled products, becomes superintendent of the new unit's flat roll division.

Louis R. Laux has joined the Alan Wood Steel Co. as general superintendent of maintenance. Before joining Alan Wood, Mr. Laux was an engineer with Inland Steel Co.

Albert C. Verel was appointed superintendent of the hot strip mill at Bethlehem Steel Co.'s, Lackawanna, N. Y., plant. He was general foreman for Seneca Iron & Steel Co. when it was acquired by Bethlehem in 1932.

William B. Wallis has been retained on a full-time basis by Strategic Materials Corp. as a consulting engineer to assist in the promotion of the Strategic-Udy Processes. Mr. Wallis was formerly president of the Lectromelt Furnace Division of McGraw Edison Co., having served in that capacity for 21 years.

Richard C. Diehl has joined Koppers Co., Inc., as a vice president in the Engineering and Construction Division. Mr. Diehl had been vice president—operations, of Universal Cyclops Steel Corp. Prior to joining Universal Cyclops in 1957, Mr. Diehl was, for seven years, president of the Chase Brass & Copper Co. Mr. Diehl also served with Armco Steel Corp. in various metallurgical assignments, and with Wheeling Steel Corp. as general manager of the firm's three plants in the Steubenville, Ohio, area.

William E. Korsan has been appointed assistant manager and **Paul W. Clark** manager of sales of the Industrial Systems Department, Allis-Chalmers Manufacturing Co. Mr. Korsan has been with Allis-Chalmers since 1942, starting as a sales representative in the Memphis, Tenn., and St. Louis, Mo., districts. He was named manager of the St. Louis district in 1955, and was transferred to the West Allis Works in 1957 as manager of sales of the Electrical Application Department, now the Industrial Systems Department. Mr. Clark came to Allis-Chalmers in 1949 and was an application engineer in the Control Department for five years, before transferring to the Electrical Application Department. He was appointed supervisory engineer in the pulp, paper and general process section in 1957.

R. G. Hammer has been appointed sales manager—western division of Refractory & Insulation Corp. He was formerly assistant sales manager and has been with the company since 1939.

L. R. Stallings has been named special products manager—sales, Union Carbide Metals Co., division of Union Carbide Corp. This new staff position has been established to provide better customer service and increased sales emphasis on a diversified group of metallurgical products. Before joining Union Carbide Metals, Mr. Stallings was Manager of sales development with the Silicones Division of Union Carbide Corp.

O. J. Gescheider has retired as assistant to the manager of the 54-in. Strip Steel Department of Weirton Steel Co. division of National Steel Corp. His duties will be assumed by **S. H. Riffee,** who has been serving as an assistant to the manager of the department. Mr. Gescheider retired after more than 43 years of service. Mr. Riffee is a 32-year veteran and has been an assistant to the manager for the past seven years.

Clarence R. Burrell has resigned as vice president in charge of sales for the Tool Steel Gear & Pinion Co., to become president of the recently organized Tool Steel Products Sales Corp. The new corporation will have its headquarters in Cincinnati, and will act as exclusive

S. H. RIFFEE

C. R. BURRELL

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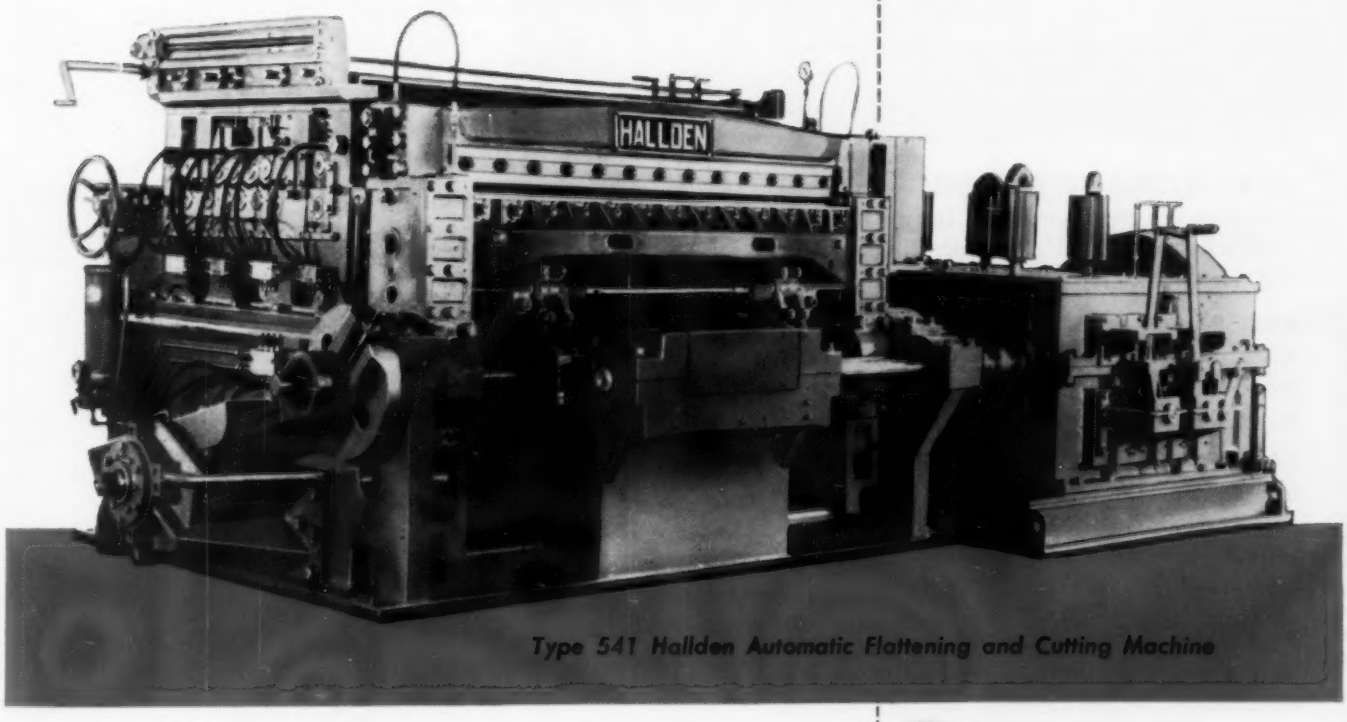

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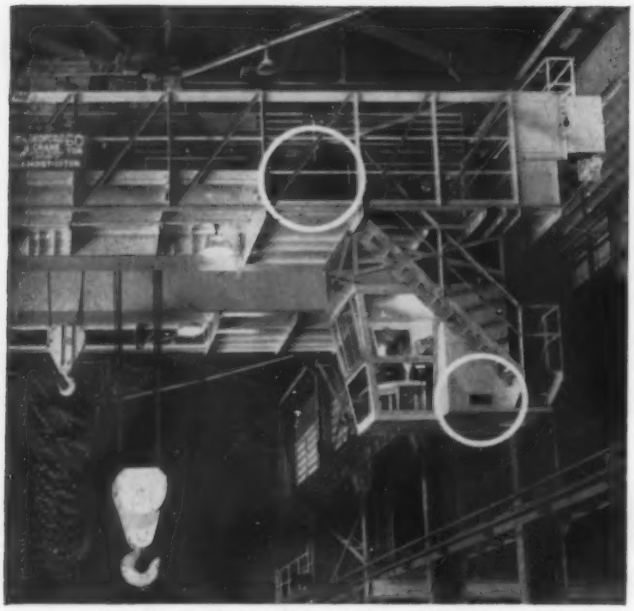

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sales agent for the Tool Steel Gear & Pinion Co. in a wide midwestern and southern area. Mr. Burrell had been in charge of sales at Tool Steel Gear & Pinion Co. for the last 18 years.

Richard F. Street has been appointed assistant superintendent of the Open Hearth and Electric Furnace Department at the Gadsden, Ala., plant of Republic Steel Corp. Mr. Street has been at Gadsden for 28 years.

R. J. Wean, Jr., has been named executive vice president, Wean Engineering Co., Inc. At the same time, **Miss H. A. Moran** was named vice president and assistant secretary, **H. W. Lynn,** vice president—sales; and **D. A. McArthur,** vice president—engineering. In addition, **G. M. Baughman,** former assistant sales manager, has been promoted to sales manager, and **M. D. Baughman, Jr.,** former assistant chief engineer, has been named chief engineer. Mr. Wean was previously vice president of the engineering concern. Miss Moran had served as assistant secretary. Mr. Lynn and Mr. McArthur held the positions of sales manager and chief engineer, respectively.

Robert F. Stewart was named vice president and assistant general manager of Western Precipitation Division of Joy Manufacturing Co. Prior to his appointment Mr. Stewart had been vice president for sales. He has served in a number of capacities including sales engineer, chief estimator, and sales manager since joining Western Precipitation in 1946. At the same time, **William E. Archer** was promoted to the position of manager of research and development. Mr. Archer joined Western Precipitation in 1950 as a service engineer in the New York office, later moving to the home office in Los Angeles. He most recently was chief development engineer for the division.

Lloyd A. Cummings has retired as vice president of manufacturing after 38 years with Marlin-Rockwell Corp. He was chief engineer for the ball and roller bearing company until 1947 when he was named vice president and appointed a member of the board of directors, a post he will continue to hold. His services will also be available to the company on a consulting basis.

John E. Johnson has been appointed assistant chief engineer of the Buffalo, N. Y., plant of Republic Steel Corp. He joined Republic's Metallurgical Department in 1949 and a year later transferred to the Engineering Department. He was appointed a field engineer in 1955 and assistant to the chief engineer in 1959.

Robert W. Bryan has been named vice president—operations, of The Youngstown Welding & Engineering Co. He was formerly vice president of The Guide Co.

Obituaries

Fredrick C. Sammons, Los Angeles, Calif., district manager of the General Refractories Co., died January 16. Mr. Sammons joined General Refractories in 1945 when the company acquired the Refractories Co. of Los Angeles. At the time, he was made manager of West Coast operations.

Nels A. Hansen, superintendent of the Rod and Wire Department of Jones & Laughlin Steel Corp.'s Aliquippa Works, died Janurary 16. He was 57, and had been employed by J&L for 33 years.

Check all SUTTON Processing Machines

for better production

ROTARY STRAIGHTENERS
Seven Roll, Five Roll and Two Roll for
Cold Drawn Bars
Hot Rolled Bars
Seamless Tubing
Welded Tubing
Upset Tubing

STRAIGHTENING PRESSES

SHAPE STRAIGHTENERS for Hexagons, Flats, Rounds, Squares, Structural and Extruded Shapes

CONTOUR CORRECTORS

PRECISION ROLLER LEVELLERS for Aluminum Sheets, Steel Sheets and Coil Processing Lines

CENTERLESS BAR TURNERS

ROTARY AND INVERTED SWAGERS

CONTINUOUS DRAWING, STRAIGHTENING AND CUTOFF MACHINES

HYDRAULIC EXTRUSION PRESSES Horizontal or Vertical for Aluminum, Steel, Brass, Lead and other Modern Metals

HYDRAULIC STRETCH-STRAIGHTENERS for Sheets, Bars, Extruded Shapes

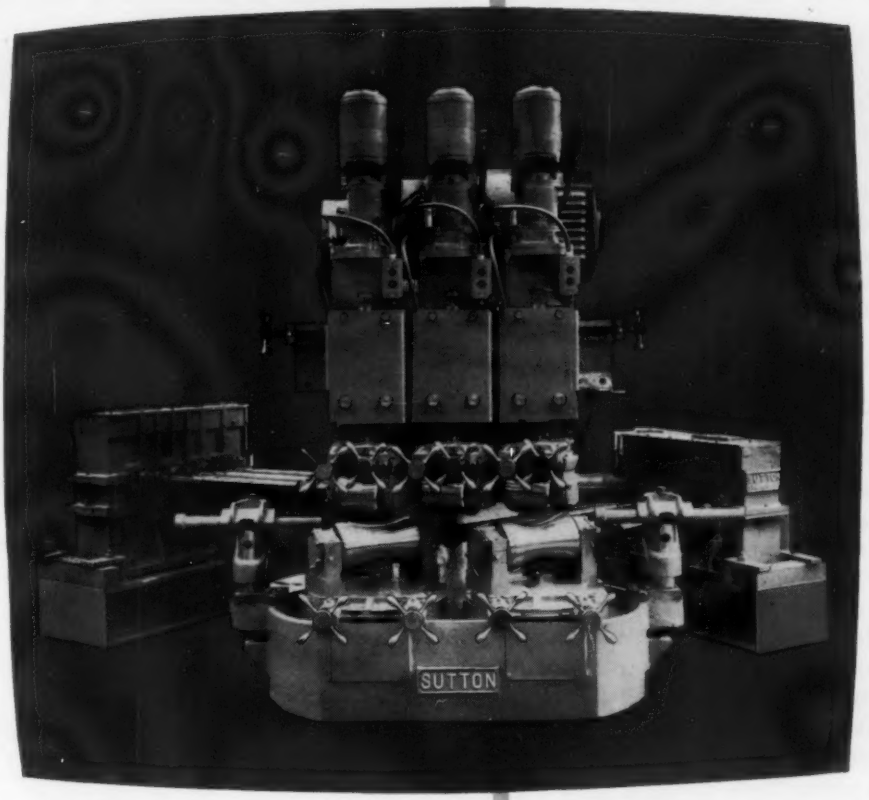
HYDRAULIC PRESS STRAIGHTENERS

ROLLS, UNIVERSAL JOINTS

Ask for specific data about the equipment you need

SUTTON
Engineering Company
First National Bank Bldg.
Pittsburgh 22, Pa.

SUTTON STRAIGHTENERS
with *Syncro-Drive*
for bars and tubes of all metals



A complete new series of
5-ROLL, ROTARY STRAIGHTENERS

For Superior Straightening at High Production Speeds

Patented Sutton Syncro-Drive provides entirely guideless, precision straightening for the finest quality end-to-end straightness of bar and tube stock.

With Syncro-Drive, users can straighten materials previously found difficult, or even impossible to straighten, such as thin-walled tubes and bars of stainless steel, brass, zirconium, titanium and other modern metals.

Model 15SD
(PICTURED)

For Bars
from 5/16" to 2" Dia.

For Tubes
from 5/16" to 3" O.D.

8 MACHINE SIZES AVAILABLE FOR BARS AND TUBES OF ALL SIZES

Ask for complete data

SUTTON *Engineering Company*
FIRST NATIONAL BANK BLDG., PITTSBURGH 22, PA.
PHONE: GRANT 1-8077 • PLANT: BELLEFONTE, PA.

Manufacturers of Straighteners, Hydraulic Extrusion Presses, Centerless Bar Turners, Rotary Swagers, Sheet Levellers and other Processing Machines for Modern Metals.

General Electric's program of Automation through Modernization can help you...

ELIMINATE CHARGING ERRORS, INCREASE FURNACE PROFITS

You can eliminate charging errors which result in unpredictable furnace operation and product quality. Now, with advanced system knowledge and new equipment developments, General Electric can automate your charging system. Automated charging of your furnace with raw materials in chemically correct proportions and in the correct sequence will give you uniform furnace operation, predictable quality, increased production, lower coke rate.

AS A FIRST STEP toward realizing these profitable benefits of automation, General Electric will help you survey your stockhouse, scale-car, and electric equipment for modernization needs. In this way, you can be sure that every component of your materials-handling system is compatible with the precise demands of automation. Then, by co-ordinating into your electrical system x-ray sensing equipment for continuous analysis of raw materials and computer equipment for burden calculating and charging direction, you will achieve fully automated furnace-charging.

ADDITIONAL SYSTEM BENEFITS will be realized through automatic acquisition of process data which have never before been available in readily usable form. Availability of these time-correlated data will make possible analysis of the process to determine the controlling relationships among blast volume, temperature, moisture, enrichment; composition of stack and top gases and raw materials; tuyere proportioning; and top pressure. When these controlling relationships are determined, the computer system can be programmed to provide immediate and accurate process direction.

ADOPT GENERAL ELECTRIC'S step-by-step program and begin now enjoying benefits of automation while you are building, practically and economically, toward the ultimate in profitable furnace operation — complete process direction from raw materials to finished iron.

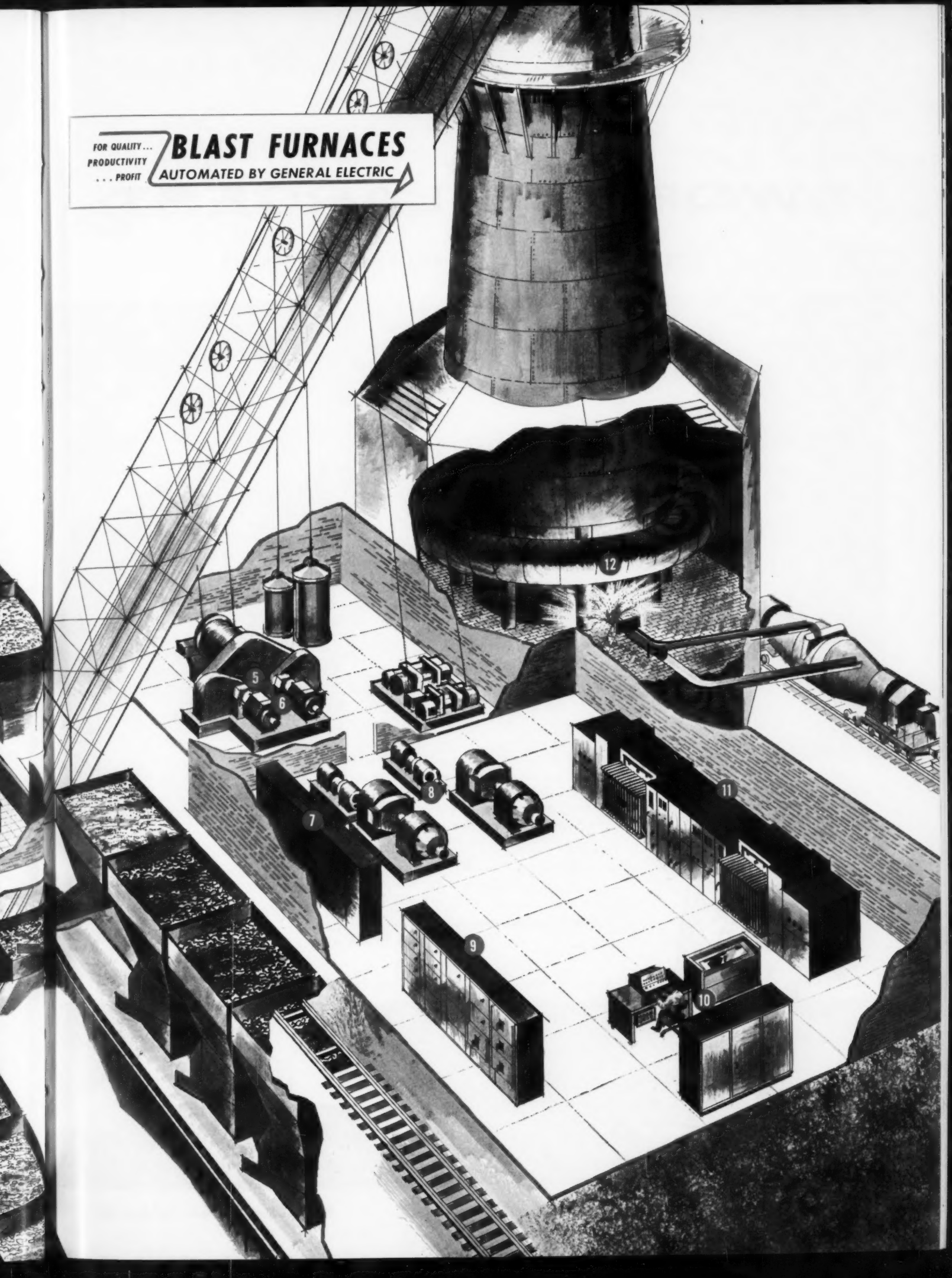
For details on this Automation through Modernization plan, call your local General Electric Apparatus Sales Office. And write for *Ring of the Future* kit, Section 659-132, General Electric Company, Schenectady 5, New York.

MODERNIZE FOR PROFITS

GENERAL ELECTRIC

SYSTEM-ENGINEERED ELECTRICAL EQUIPMENT

1. Recording and indicating instruments.
2. X-ray equipment for raw-materials analysis.
3. Operator's console.
4. Intra-tel closed-circuit television.
5. Heavy-duty brakes.
6. D-c mill motors.
7. Skip-hoist and d-c auxiliary drive control; DIRECTO-MATIC static charging control.
8. Skip-hoist motor-generator sets.
9. Motor-control centers.
10. GE-312 digital computer system.
11. Selectively Co-ordinated load-center unit substation.
12. Blast from steam-turbine or electric-driven blowers.


FOR QUALITY... PRODUCTIVITY ... PROFIT
BLAST FURNACES
AUTOMATED BY GENERAL ELECTRIC
5
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12

WORLD'S LARGEST

The intensified grip is produced by the weight of the column plus the weight of the ingot. The intensified grip has the same grip without an ingot in the tongs as a conventional soaking pit crane has with an ingot. Therefore the initial grip is much greater than the conventional soaking pit crane. Either motor can raise the column out of a soaking pit.

During the past twenty years, THE ALLIANCE MACHINE COMPANY has built over 50 intensified grip soaking pit cranes for some of the world's largest mills.

This vast experience in engineering and manufacturing means the most complete availability in a full range of capacities and types of SOAKING PIT CRANES.

For the greatest return for your investment, look to ALLIANCE.

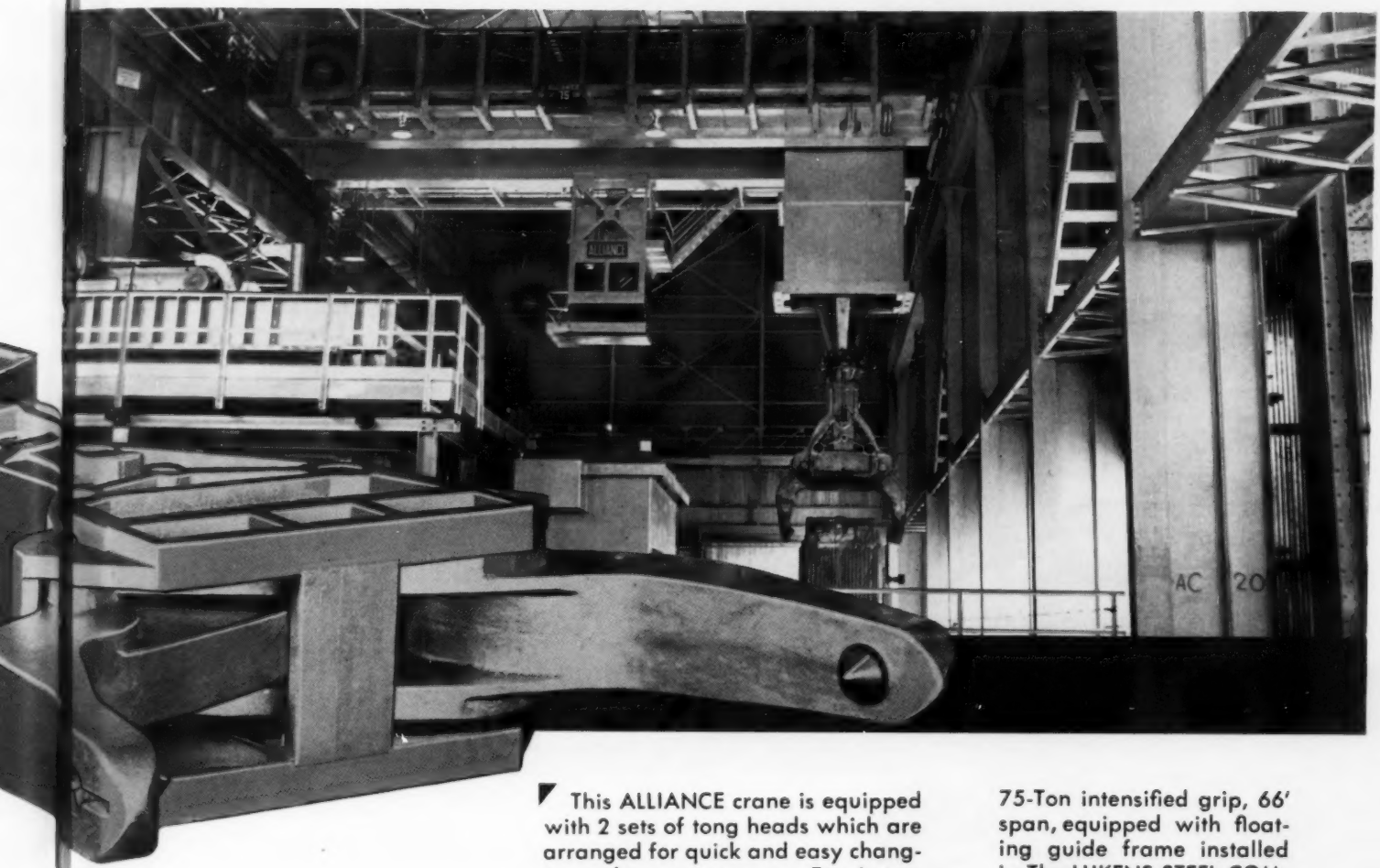
Alliance

machine company

Main Office Alliance, Ohio

SOAKING PIT CRANE

(with intensified grip)



This ALLIANCE crane is equipped with 2 sets of tong heads which are arranged for quick and easy changing when necessary. For ingots weighing from 5-30 tons the smaller head is used with a range from 10" - 48". For 30-75-ton ingots the larger head is used with a range from 45-80".

75-Ton intensified grip, 66' span, equipped with floating guide frame installed in The LUKENS STEEL COMPANY, Coatsville, Pa.

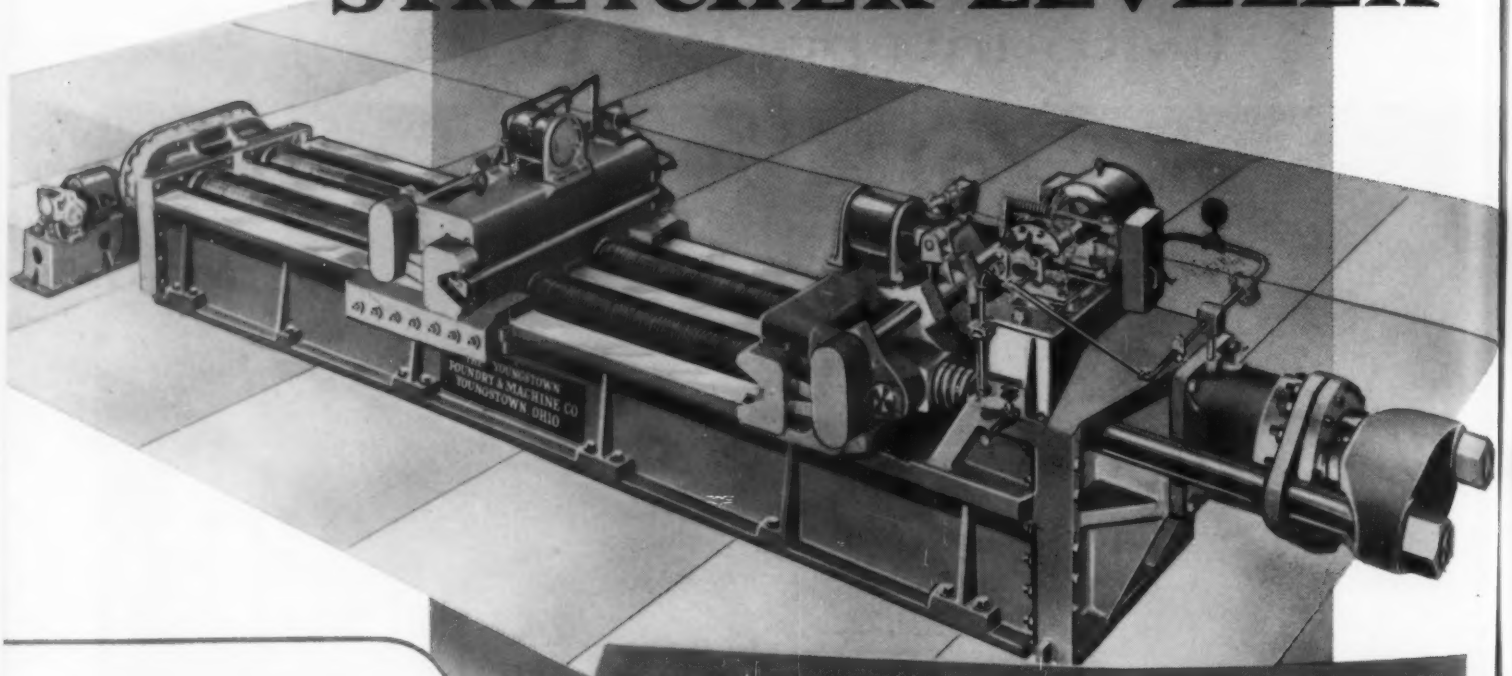
"Give Us The Runway and We'll Lift The World"

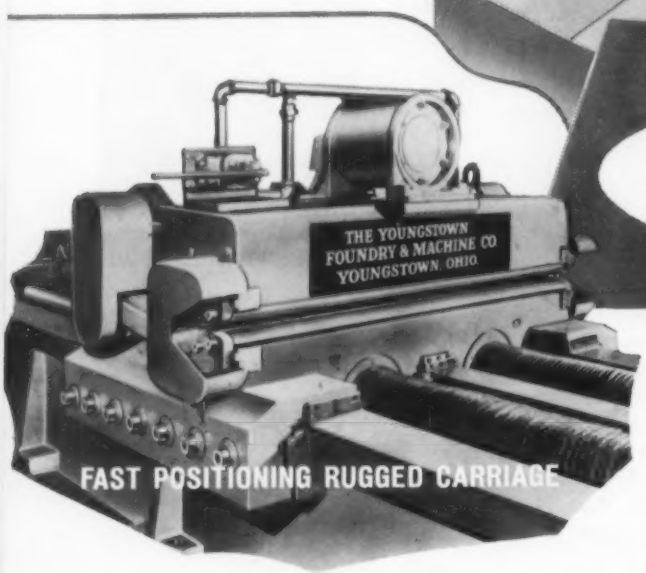
Overhead Cranes * Gantry Cranes * Mill Cranes and Equipment * Hot Metal Cranes Ladle Cranes * Stripper Cranes * Soaking Pit Cranes * Soaking Pit Cover Cranes Charging Machines * Furnace Chargers * Slab Handling Cranes * Bucket Cranes Magnet Cranes * Mold Yard Cranes * Skull Cracker Cranes * Ingot Buggies * Run-Out Tables * Car Dumpers * Special Mill Equipment * Ore & Coal Bridges * Loading & Unloading Towers * Forging Manipulators * Forging Cranes * Power House & Dam Cranes * Dock & Pier Handling Equipment * Research, Development & Engineering Service * Licensees & Manufacturing Facilities in Other Countries.

"YOUNGSTOWN"

New Carriage-Type Design

STRETCHER LEVELER





a small difference in design makes a big difference in RESULTS...

CONSERVES VALUABLE FLOOR SPACE
SPEEDS STRETCHING OPERATION
AIDS QUALITY CONTROL

WEDGE TYPE HEADS with WAFFLE TYPE GRIPPER JAWS assure flatness of sheet-ends.

Rugged Three Way fabricated Steel Bed insures utmost rigidity.

The Hydraulic Stretcher Leveler pictured is 800,000# Capacity capable of stretcher leveling mild cold rolled sheets 30" to 62" wide, 30" to 168" long, up to .180" thick in either single or multiple sheets.

A complete range of sizes . . . built from 10,000# for aluminum extrusions to 2,000,000# for stretching plate. New performance throughout a long life of service is assured by traditional "YF&M" rugged construction.

Write for Complete Information.

The Youngstown Foundry & Machine Company

Serving Industry Since 1885

Youngstown 1, Ohio

Equipment News...

ALL-BASIC OPEN HEARTH

△ The Refractories Division, H. K. Porter Co., Inc., has announced its all-basic open hearth furnace, which incorporates the industry's most advanced all-basic open hearth roof utilizing Porter basic refractory brick.

This new concept in roof and end-wall suspension employs the present fundamental construction now in use. Both incorporate a new, all-metal cladding method to provide proper expansion allowance throughout the entire system.

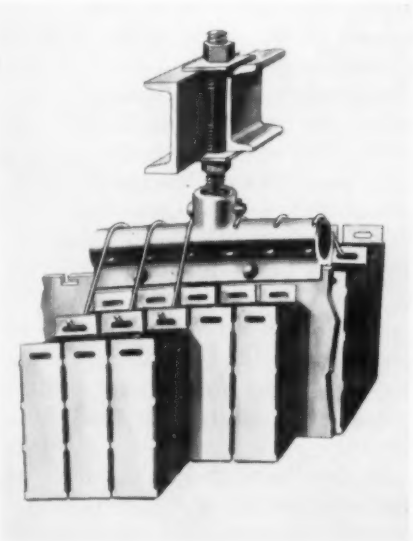
Brick are individually wrapped in metal, rather than being fitted to preshaped cases.

Porter roof suspension has these new and unique advantages:

1. A built-in air cleaning and air cooling system, which covers the entire roof.
2. Simple inexpensive tab supports for brick.
3. Notched tie plates that slip into place, are anchored to pipes for positive support.

Because extended use of basic refractories enables furnaces to operate at higher temperatures, oxygen lances are incorporated into the Porter roof design. Oxygen thus injected results in higher internal heat which hastens the melt by making possible faster chemical changes.

The Porter roof design can save up to 12 hours rebuild time in making major furnace repairs.



STACK HEADS ENROUTE TO FAIRLESS

Built to prolong the life of soaking pit furnaces of U. S. Steel Corp.'s Fairless works by eliminating wind-caused heat fluctuations, these draft equalizing stack heads are the largest ever built by the Moran Furnace and Sheet Metal Co., Tulsa, Okla. The stack heads measure 18 ft tall and 12 ft in diam, weighing 3000 lb each. They were ordered by Swindell-Dressler Corp., now in the process of erecting the new soaking pit furnaces.

CONTROLLERS

△ New front-connected controllers which eliminate the need for back aisle space on crane walkways have been announced by EC&M Division of Square D Co. All wiring and control components are accessible from the front, with ample working space inside the cabinet. Only one man is required for maintenance.

The new controllers can save up to 20 in. of catwalk width. They are 10 to 15 per cent lighter than equivalent controllers with conventional wiring, providing a reduction in crane weight.

Control components are mounted on insulated bases which in turn are mounted on panel studs projecting from the rear of the cabinet. This arrangement assures maximum insulation to ground for extra safety. The exclusive Wright dynamic lowering circuitry gives maximum hook speed without danger of overspeeding.

Furnished with 2, 3 or 4 decks to suit headroom requirements, the new front-connected controllers are available for single-motor d-c drives up to 225 hp.

VENTILATING FANS

△ Six centrifugal Westinghouse ventilating fans are part of a flexible new ventilating system for mill motors at the Middletown, Ohio, Works of Armco Steel Corp. These fans, each rated at 32,000 cfm, provide sufficient cooling air in the hot strip mill motor room to maintain rated motor output.

Installed as part of a revamping project at the plant, the ventilating units are adapted for individual control of the cooling air to each motor for optimum operation. They replaced a previous central supply system with a single fan which could not keep pace with additional cooling loads required by increases in motor output.

Designed and manufactured by the Westinghouse Sturtevant Division, these general purpose centrifugal fans are equipped with vane control to adjust air volume between summer and winter requirements. This design assures the required amount of cooling air to

NO EQUAL

It's common knowledge everywhere that Super #3000 Refractory Mortar has no equal. After you use Super #3000 you'll see why "putting up" with other bonding and patching mortars just doesn't pay.

BLAST FURNACE

Super #3000 pumped into voids in lining in order to eliminate hot spots. Customer says Super #3000 works better in pump than any materials previously used (pumped higher than 200 feet). Sets quickly in void. Excellent patch.

USE SUPER #3000 AS A GENERAL PURPOSE BONDING AND PATCHING MORTAR. IT'S THE LOWEST PRICE INSURANCE YOU CAN BUY.

R&I

REFRACTORY & INSULATION CORP.

136 WALL STREET • NEW YORK 5, N.Y.

Sales Offices: Chicago, Ill.; Cleveland, Ohio; Bryn Mawr, Pa.; Newark, N. J.; Buffalo, N. Y.

Manufacturers of Castable and Bonding Refractories; FURNACE BLOK; Blankets, Block, Plastic and Fill Insulations.

all motors and permits adjustments to be made readily. A 30-hp motor drives each of the fans.

HEAVY CAPACITY TRUCK

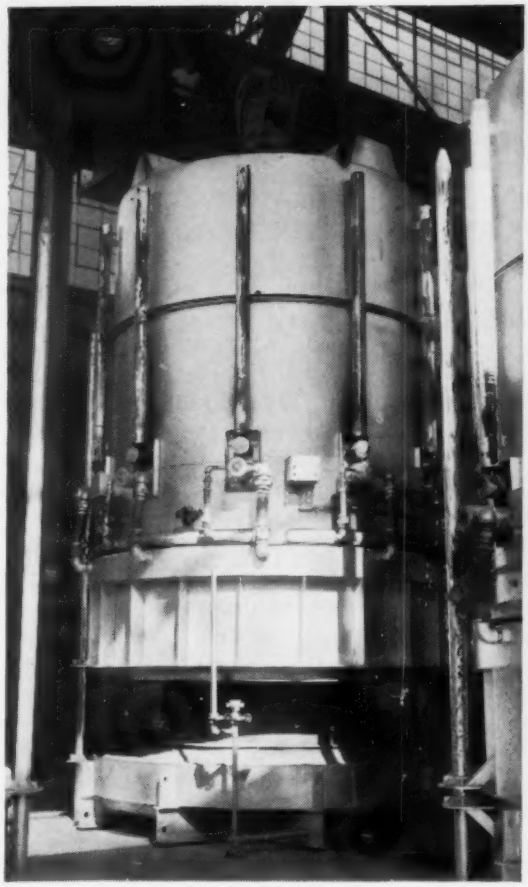
△ Automatic Transportation Co.'s new version "Elbolift," gas-operated electric-driven, provides a mastless industrial truck which obtains maximum fuel efficiency and economy plus the ability to move heavy steel coils in and out of boxcars and stack 120 in. high.

Two field proved units have been combined to give the maneuverability of the "Elbolift" and constant power, which supplies the exact amount of electric power to the drive motor through a variable voltage generator that is coupled to a gas engine.

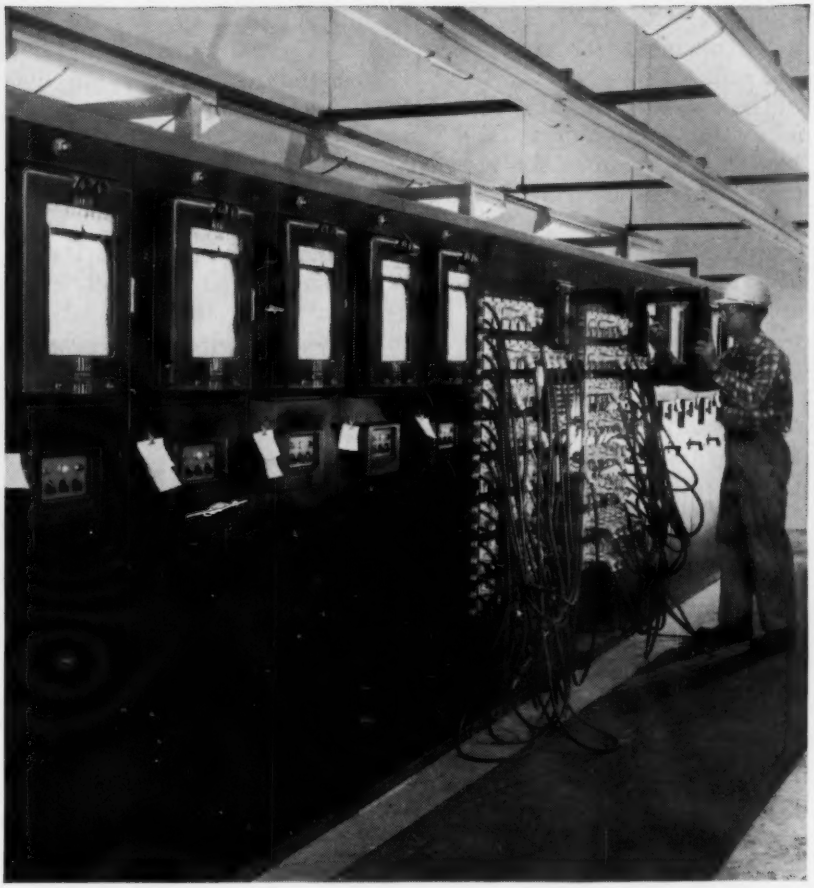
The stand-up, end-control unit has been designed to perform all

the functions required of an industrial truck in steel mill or heavy duty operations, yet, driver safety and convenience have been maintained. New swept back designed plexi-glass guards provide maximum driver safety without impairing visibility. Gate type guard also protects the operator from backing into protruding objects. Full-time power steering assures safe, easy handling. The directional handle has an indicator to denote the position of steer wheels at all times. One lever operates forward and reverse speeds plus lift and tilt control. The operator also has a foot operated inching control and hydraulic wheel brakes.

A 4-cylinder F-162, Continental engine slides out of its compartment on roller channels for easy inspec-



Single stack annealing furnace



Switching panel design provides flexibility

Modern Design in Annealing Furnace Control

Lee Wilson single stack furnaces feature two-point temperature control

Armco Steel Corporation's Middletown Works is "bustin' out all over" in expansion and modernization programs. New strip mill capacity has necessitated additional annealing facilities with 18 new Lee Wilson covers utilizing 54 bases and featuring the most modern systems for temperature control, a vital factor in quality annealing. These control systems depend on L&N Speedomax® G strip-chart controllers, designed especially for Lee Wilson Engineering Co., Inc. to help get peak efficiency from their modern design furnaces.

Each multiple-point recorder-controller provides essentially two separate control systems: one for furnace temperature, one for work temperature. The control units are combined in a single package and provide full proportional control of two temperatures. When the annealing cycle begins, control of furnace temperature is maintained from a thermocouple located in the lower portion of the furnace between the radiant tubes. Another couple, imbedded in the bottom of the coil, monitors load temperature. When the load temperature reaches a predetermined point, control is automatically switched to the load couple for the remainder of the annealing period.

For record purposes, top load temperatures are detected by thermocouples in the top of the coils and are printed out, in turn, on the strip-charts of the same Speedomax recorders.

The Speedomax temperature control systems for these new Lee Wilson furnaces are examples of the creative engineering attention that will be directed to your control problem by especially qualified people at Leeds and Northrup. If you have a control problem, large or small, call your nearby L&N office or write 4942 Stenton Avenue, Philadelphia 44, Pa., for the answer.

LEEDS & NORTHRUP
Instruments — Automatic Controls • Furnaces

tion. It can be operated, from either straight gas or LPG fuel. When equipped with LPG, the tank is roller mounted for easy removal and refill.

The versatility of this drive permits the smooth ride and fast acceleration required for industrial truck applications. Torque multiplication is 8 to 1. All clutches, fluid coupling, fluid torque converters or multiple speed transmissions are eliminated, thus less maintenance, less downtime and more productive output is achieved.

Optional equipment is a split ram, fork attachment with built-in side shifter that permits accurate positioning of loads.

The gas operated, electric-driven truck is built in capacities from 15,000 to 20,000 lb. The battery powered unit is available in 12,000 to 25,000 lb capacities.

CURVED REFRACTORIES

△ With curved Furnace Blok, it is now possible to construct monolithic walls of circular furnaces without using wooden forms. The curved product is a variation of standard straight Furnace Blok manufactured by the Refractory & Insulation Corp.

Curved Furnace Bloks, like the standard product, are hollow refractory units which are placed in position, then filled with special pour-type refractory. When the fill has set, a unified monolithic structure is formed. There are no joints. Compared to the construction of a circular firebrick wall, the saving in time and labor is quite considerable.

The product is at present being manufactured of radii of curvature to accommodate furnaces of 11 ft diameter and greater.

WOUND ROTOR MOTORS

△ New wound rotor induction motors designed primarily for adjustable or constant speed drives that require special starting characteristics are available from Westinghouse Electric Corp. The new motors cover all standard ratings in frame sizes 254 through 326, which represents motors from 2 to 30 hp up to 1800 rpm.

The wound rotor induction motors

are used wherever high-starting torque with low-starting current is required. They find a wide range of use in severe reversing, plugging service and for frequent starting and stopping in such applications as cranes, hoists and bending rolls.

In superseding the types CWP and CIP wound rotor motors, the new line incorporates a Class B insulation system which offers greater thermal stability, outstanding moisture resistance and inertness to chemicals and dirt. The limits on starting torque, pull-out torque, inrush current, temperature rise and other characteristics have not been changed.

Other features of the new design

EXECUTIVE REPORT #4

HEALTHY MOTORS BREATHE ULTRA-PURE AIR

...cleaned by WHEELABRATOR® air filters

Your investment in steel making equipment is too big to take a chance on motor failure resulting from dust in the atmosphere. Especially when Wheelabrator Ultra-Filtration air filters can provide essential air purity at minimum cost.

In prominent American and Canadian steel plants, Ultra-Filtration today is providing over 5,000,000 cfm of super-clean air for motor rooms, control rooms, electrical equipment and turbo blowers.

The low cost of operating Wheelabrator Ultra-Filtration air filters is gratifying, too. No liquids, oils or tacky materials are involved — there is no problem of sludge removal. In one typical installation, *absolutely* no maintenance cost has been experienced in filtering over 394,000 000,000 cf of air.

Ultra-Filtration provides any degree of air purity you require, at minimum cost

Ultra-Filtration delivers collection efficiencies above 99% by weight and 95% by blackness test, even when filtering sub-micron size particles. For illustrations of highly efficient Dustube installations, write for Catalog 562-D. **Wheelabrator Corp., 396 S. Byrkit St., Mishawaka, Ind. In Canada, P. O. Box 490, Scarborough, Ont.**

WHEELABRATOR
DUST AND FUME CONTROL

include sealed-for-life, lubricated ball bearings. Seals prevent dirt from entering and lubricant from escaping regardless of mounting position of the motor.

Also, brushholders are placed for maximum access through extra large hand holes. The unique spring-and-lever arrangement eliminates need for pressure adjustments during brush life.

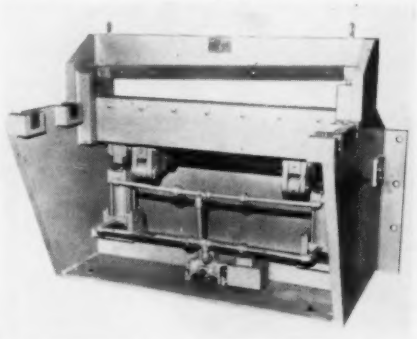
The conduit box is diagonally split and provides flexibility and ease of installation. A wiring diagram inside the box cover, together with lead tags, make for simple connections. The conduit box can be rotated for bottom, horizontal or top entrance. Squeeze connectors are provided for secondary leads. The motors are supplied with leads for external connection for either 220 or 440 volts.

"Load-O-Matic" control, which contains a minimum of control components, and eliminates reversing contactors and rotating conversion equipment, is available for use with the new wound rotor motors. The controller is front wired in channels, which saves space and time during installation.

HYDRAULIC SHEARS

△ A new series of hydraulically-operated mill-mounted shears for cutting fishtails from leading and trailing ends of strip and sheet has been introduced by Curry Air Shear Corp. The shears supplement the air-operated shears previously available from the company.

Designed to operate from the mill's hydraulic system, these up-



cut shears are more compact than any previously available for this service. The shear is bolted directly to existing or new mill housings, and sheet or strip passes from mill rolls between the knife blades. Operation is by push button from the roller's control panel.

Models of the shears are available for cutting 24 to 84 in. wide strip and sheet.

D-C MAGNET BRAKE

△ General Electric Co. has redesigned its line of d-c magnet brakes to provide increased reliability and simplified maintenance.

Key features of the redesigned d-c brake family are an improved epoxy-potted magnet coil assembly, single-end adjustment, and exclusive slip-in brake lining replacement. All adjustments and settings are made from one end of the brake.

The d-c magnet brakes, in 8, 10, 13, 16, 19 and 23-in. wheel sizes, are spring-set, shoe type friction brakes, built to NEMA-AISE standards by the Industry Control Department, Salem, Va. They can be either left- or right-hand mounted with no change in pins or bolts required. Although designed for floor or ceiling mounting, they can be adapted for motor-mounting or vertical mounting. They are widely used in braking and holding steel-mill drives, cranes, hoists, movable bridges, conveyors and other in-

EXECUTIVE REPORT #15

THIS WHEEL PLAYS 9 ROLES

To Cut Costs for Steel Producers

In the production or fabrication of steel, the Wheelabrator airless abrasive blast wheel is playing 9 or more starring roles. It excels as a cost- and time-saver in descaling strip, sheets, plate, bar stock, skelp, structural shapes, wire rod, slabs and billets, at mill roll etching, ingot mold conditioning, and other specialized applications.

Wheelabrator mechanical descaling of steel reduces the cost of acid pickling, reduces man-hours of work, requires less floor space than pickling equipment, substantially lowers cleaning costs and enables straight-line automated production. And it results in a superior surface for cold rolling, cold forming, cold and deep drawing, and for adherence of all types of metal finishes.

Over 100 Applications prove Wheelabrator Cost Savings

Wide use throughout the steel industry has proved the Wheelabrator process. For engineering consultation on your problem, write Wheelabrator Corp., 396 S. Byrkit St., Mishawaka, Ind. In Canada, P. O. Box 490, Scarborough, Ont.

WHEELABRATOR
AIRLESS BLAST EQUIPMENT

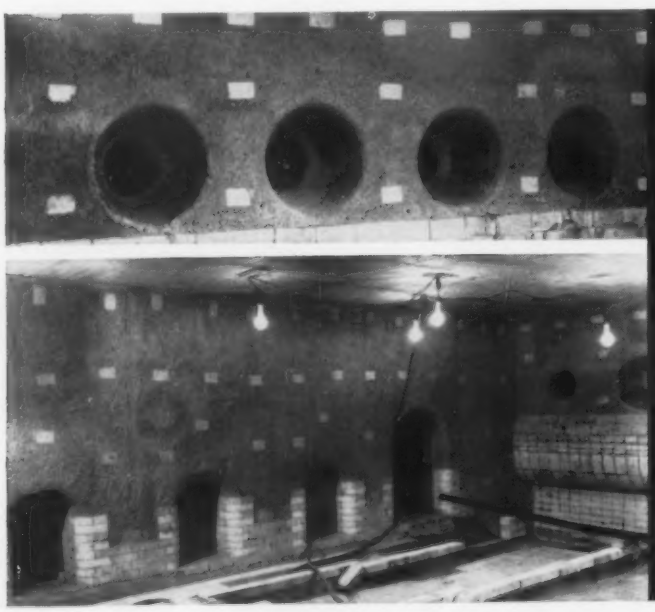
dustrial uses where continuing service and low operating costs are of first importance.

Design improvements in the magnet coil assembly simplify the job of replacing coils for brake rating changes or maintenance. When unbolted, the complete coil and magnet housing assembly can be hoisted vertically from the brake frame with a simple lift.

Coil construction is designed to insure high reliability in the most rugged service. High-temperature Mica-mat insulation protects magnet coil windings. The leads from magnet coil to terminals are protected by silicon-glass tape. The entire coil is encapsulated in high-strength epoxy resin compound, sealing out dust, moisture and oil and giving "strongbox" protection against mechanical damage.

A new "positive-holding" pivot arm aligns both brake shoes for even pressure and locks this adjustment to prevent misalinment due to vibration or load.

When normal wear necessitates replacement of brake linings, the d-c magnet brakes are back in service in a matter of minutes. Exclusive slip-in brake lining replacement permits old linings to be removed and new ones inserted without removing the brake shoe assembly. The maintenance man releases the brake by means of its manual release mechanism. He removes two holding bolts which position each lining to the shoe, and slips the old lining out of its grooved track with a screwdriver.



PLIBRICO "Super" and PLIBRICO "Super F" plastics form a continuous, fully-anchored monolithic lining for the side walls and burner walls, with smooth contours around the door arches and burner cones, in this Salem-Brosius slab reheating furnace.

Plibrico plastic refractories selected at Inland Steel Co. for 130 tons/hr slab reheating furnace

Properties of Plibrico "Super" and Plibrico "Super F" plastic refractories are geared to the demands of this 99′ triple-fired slab reheating furnace placed in service in 1958 at Inland's 76″ mill. Capable of withstanding severe conditions, Plibrico "Super" lines the preheat zone, while Plibrico "Super F" lines the high heat and soaking zones.

Less maintenance—longer service life assured . . . formulated specifically for tough assignments, Plibrico "Super F" is highly resistant to stresses, vibration, mechanical and thermal shock. It is exceptionally stable, and with its low porosity resists destructive penetration of otherwise harmful combustion by-products.

For furnace linings that cost less and last longer, call your local Plibrico distributor-engineer . . . WRITE FOR CATALOG 69 covering steel mill, industrial and foundry applications

Plibrico REFRACTORIES

Serving the Furnaces of Industry 24 Hours a Day

PLIBRICO CO., 1804 Kingsbury, Chicago 14 • Canadian Plant: New Toronto, Ont.

Plibrico Sales and Service Throughout the World

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Book Reviews

"Structure and Properties of Thin Films," edited by C. A. Neugebauer, J. B. Newkirk and D. A. Vermilyea has recently been published by John Wiley & Sons, Inc., 440 Fourth Avenue, New York 16, N. Y. The book contains 561 pages, 8½ x 11 in., is cloth bound, and sells for $15. This book presents the complete proceedings of an international conference on thin films held at Bolton Landing on Lake George, N. Y., September, 1959. Review papers, contributed by 58 internationally known contributors, experts in their specialized fields, discuss topics including preparation, growth and structure of thin film; the mechanical, electrical, optical and magnetic properties; and a review of processes occurring at the metal surface. Current research papers describe some of the more fundamental problems of physics and chemistry involved in the special nature of thin films. The problem of ferromagnetism in very small specimens; the nature of chemisorption, and the effects of small dimensions on various properties receive prime attention. A complete transcript of the conference discussions is included. Numerous illustrations, photographs, diagrams, graphs, charts, are used.

"Industrial Minerals and Rocks (Nonmetallics other than Fuels)" third edition completely revised, Joseph L. Gillson, Editor-in-Chief, sponsored by the Seeley W. Mudd Memorial Fund, has been recently published by The American Institute of Mining, Metallurgical and Petroleum Engineers, 29 West 39th Street, New York 18, N. Y. The book contains 934 pages, 9 x 10 in., is cloth bound, and sells for $12.

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This edition is almost entirely rewritten to keep pace with the rapid changes occurring in the technology, industrial applications and usefulness of the industrial minerals. The book is comprised of 56 chapters each discussing a different industrial mineral, and consists of the contributions of experts in the field of each material.

"Random Vibration," edited by Stephen H. Crandall, has been published recently by John Wiley & Sons, Inc., 440 Fourth Avenue, New York 16, N. Y. The book contains 423 pages, 6 x 9 in., is cloth bound and sells for $8.50. The material in this book was prepared for the special summer program on Random Vibration held at the Massachusetts Institute of Technology in 1958. The book is intended for engineers already familiar with the classical problem of mechanical vibration and described are the new concepts required to extend ordinary vibration theory into the field of random vibration, and contains a broad picture of the current state of the art of designing and testing equipment which must withstand random vibration. It discusses the basic concepts and background material as well as problems of designing and testing. Numerous tables, charts, diagrams and equations are employed throughout the text.

"Handling and Treatment of Iron Ores" (Special Report No. 65) has been published recently by the Iron and Steel Institute, 4, Grosvenor Gardens, London, S. W. 1, England. This report consists of 128 pages, 8½ x 11, is cloth bound, and sells for 3 pounds, 5 shillings. The book contains papers presented at the meeting of the Iron and Steel Engineers Group in The Netherlands, April 14–17, 1959. There were six papers presented at the first session which covered ore-handling installations and facilities and problems at Rotterdam; Contrecoeur, Quebec; Seven Islands, Quebec; in Great Britain; and also unloading iron-ore ships in the U. S. A. and Canada. The second session consisting of five papers concerning crushers and crushing; screening blast-furnace burden materials; problems of ore handling—experiences at the Margam Works, Port Talbot, and experiences at East Moors, Cardiff; the handling of raw materials in a modern iron and steel works; and ore preparation and blending. Discussions of these papers are also reported. Two other papers are reported—Ore-handling facilities at IJmuiden and freight costs of large ore carriers. Many photographs, tables, and diagrammatic drawings are included in the report.

"Nuclear Power Plant," by E. Openshaw Taylor has been published recently by Philosophical Library Inc., 15 East 40th Street, New York 16, N. Y. The book contains 184 pages, 5½ x 8½ in., is cloth bound, and sells for $7.50. This book provides a review of the basic ideas underlying nuclear power generation. It opens with a concise account of world energy requirements and resources present and future. It discusses nuclear and reactor physics, types of reactors, reactor engineering, instrumentation and control and the economies of nuclear stations. Comprehensive tables of elements and a chronology of nuclear power are presented in the

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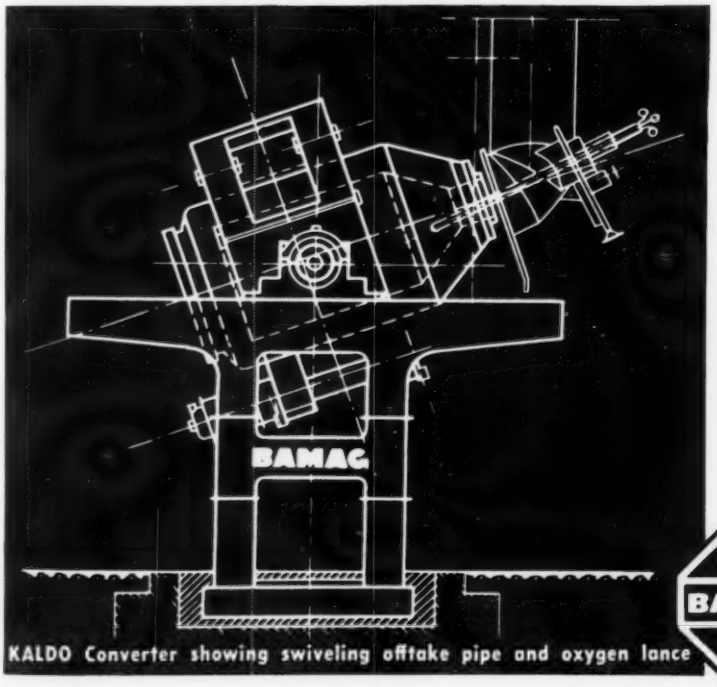

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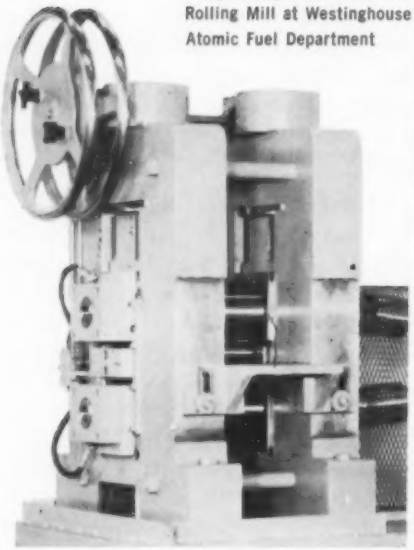

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appendices. Numerous equations, linear drawings and tables supplement the text.

"Fracture," edited by B. L. Averbach, D. K. Felbeck, G. T. Hahn and D. A. Thomas, has been published recently jointly by John Wiley & Sons, Inc., 440 Fourth Avenue, New York 16, N. Y., and the Technology Press of Massachusetts Institute of Technology. The book contains 646 pages, 6 x 9 in., is clothbound and sells for $17.50. The book contains the proceedings of an international conference on the atomic mechanisms of fracture held in Swampscott, Mass., April 12–16, 1959, sponsored by the National Science Foundation, Office of Naval Research, Air Force Office of Scientific Research, Ship Structure Committee. It was organized and directed by the Conference of Fracture of the National Academy of Sciences—National Research Council. The book contains 28 papers presented by the world's outstanding research workers in the field. Current theories and experiments are critically considered for the cleavage, ductile, fatigue and high temperature mechanisms of fracture for metals, ceramics and polymers. The book is concerned with the question of what actually occurs on an atomic scale when materials fracture.

"Nature and Properties of Engineering Materials," by Zbigniew D. Jastrzebski has been published recently by John Wiley & Sons, Inc., 440 Fourth Avenue, New York 16, N. Y. The book discusses materials from a chemical viewpoint, contains 571 pages, 6 x 9 in., is cloth bound and sells for $11.00. This book considers the basic concepts of interatomic and intermolecular forces and their relationship to the structural characteristics of both crystalline and amorphous materials, followed by the discussion of such phenomena as diffusion, crystallization, phase transformation and phase equilibria; with these principles developed, considering more specifically, the characteristic properties and uses of a wide variety of engineering materials. The author includes information previously only available in specialized higher level reference books, and presents it in a manner easily understood by a nonspecialist.

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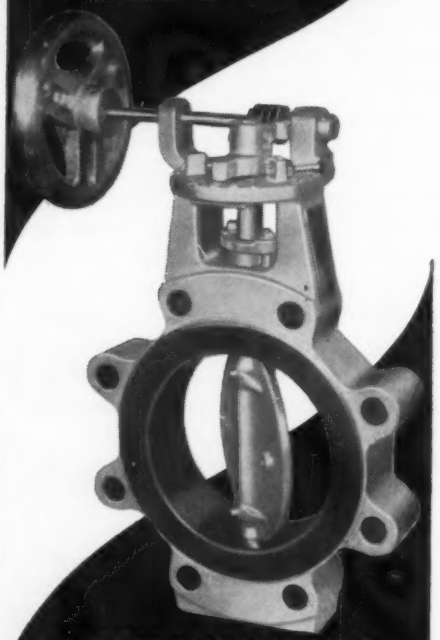

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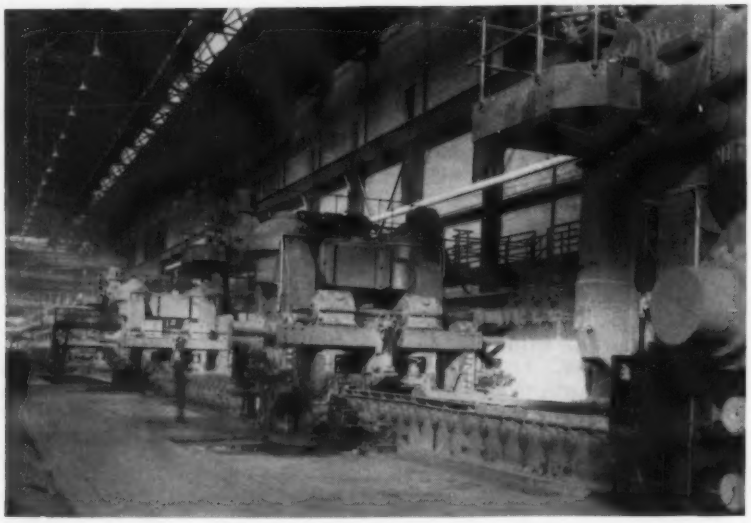

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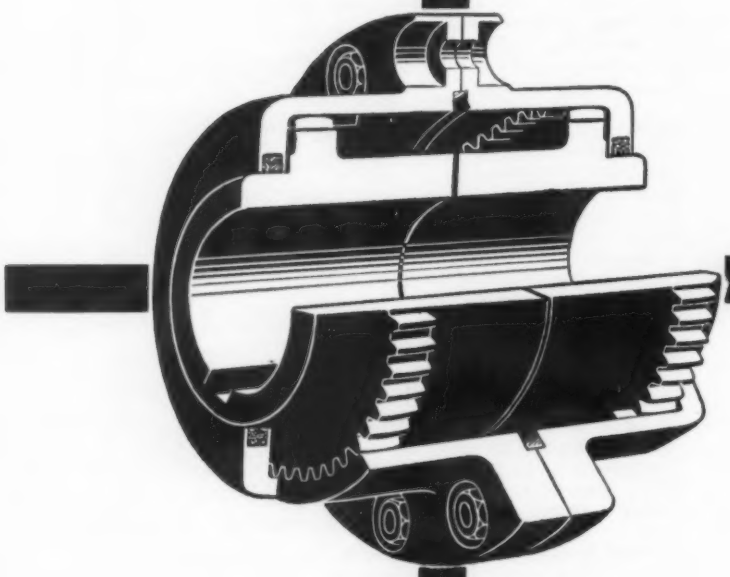

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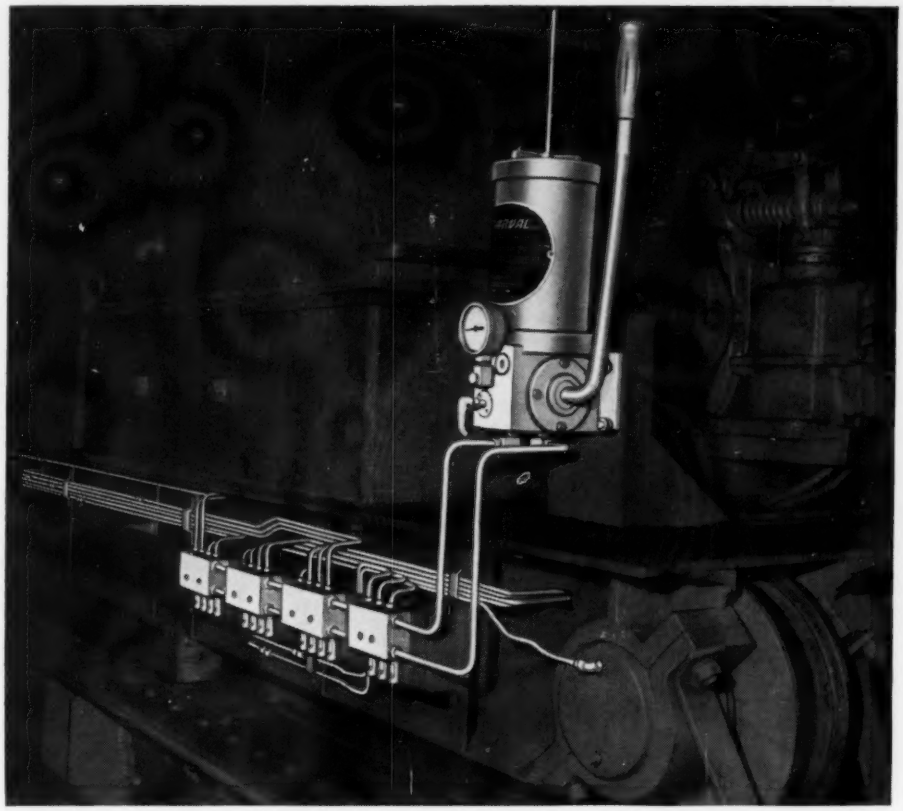
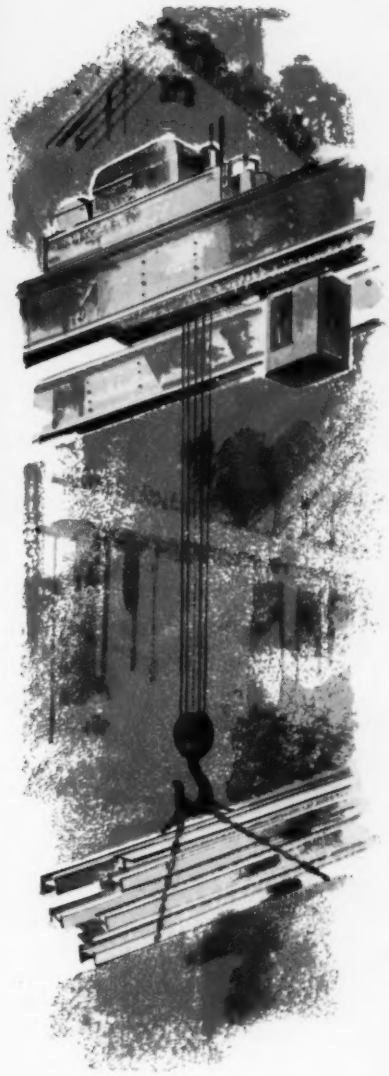




Farval lubrication keeps Westinghouse crane on 'round-the-clock operation

Here's a close-up of the trolley of Crane No. 187 at Westinghouse Electric Corporation's giant East Pittsburgh Works. It was recently "Farvalized" along with the bridge to permit continuous operation at top efficiency for long periods of time—without downtime for expensive grease gun and oil can types of manual lubrication.

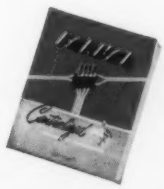
Note how the valve bank has been manifolded so that all points in valve operation will be visible to the operator as he "shoots" the system.

Farval Centralized Lubricating Systems make sure that accurately metered amounts of lubricant will reach every vital crane bearing from a safe and centrally located station. These versatile Farval systems easily deliver any pumpable lubricant—show substantial savings in both time and lubricant.

Plant operators report, "Farval lubrication is safe, and dependable. We find crane repairs and maintenance are reduced—operating power consumption much less!"

Farval Studies in Centralized Lubrication No. 248

Ask your local Farval Representative for the complete story on how all types of industrial machinery and equipment produce better, more economically when "Farvalized." It's also contained in free Bulletin 26-S. Write for your personal copy, today.



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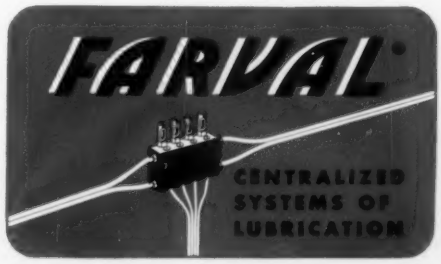
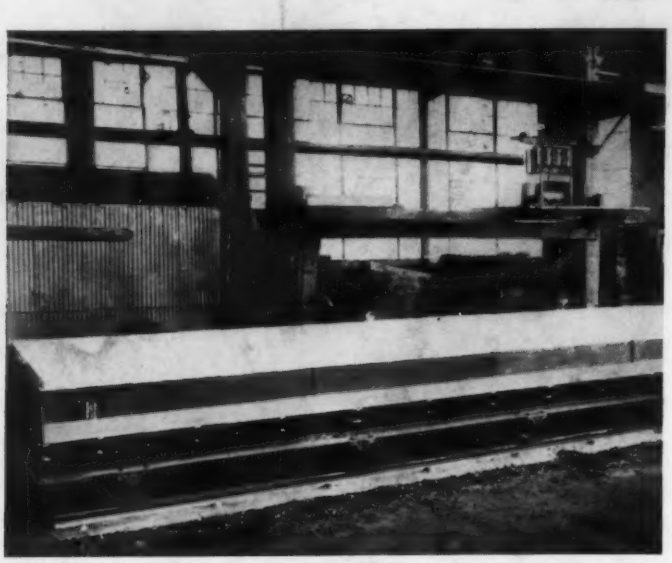
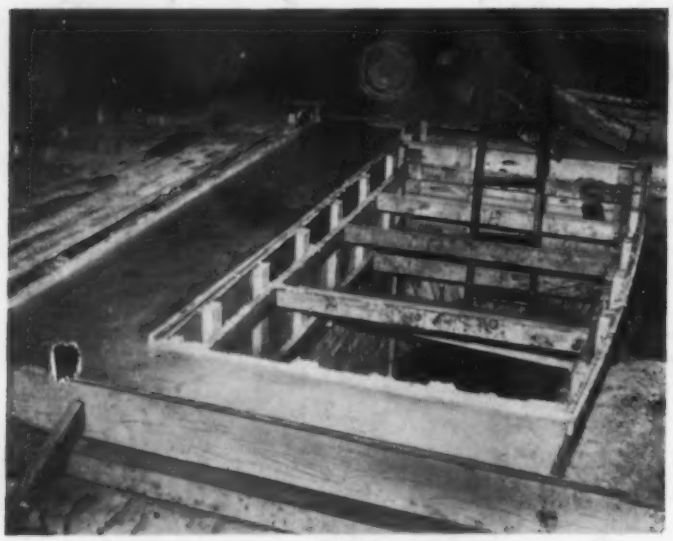


In this stress-relieving furnace, B&W Kaocrete-D is used on the floor ledges, car top, in the door jamb and at the end of the flat roof where it withstands the abrasion of the door. This material is specially designed to withstand severe abrasive conditions and mechanical abuse.



Heavy duty car top service requires a high strength castable. B&W Kaocrete-D is excellently suited for this service at temperatures to 2500 F. B&W Kaocrete-32 is recommended for service above this range.



B&W Kaocrete-32 has been cast to form the curb walls of a soaking pit. When mechanical abuse from ingots damages the curb, Kaocrete-32 has the necessary properties to localize the damage, thus maintaining the serviceability of the rest of the curb.

The castable lining of this aluminum reverberatory furnace must have unusually high strength to withstand the considerable physical abuse of charging, operating and cleaning, while resisting the penetration of the molten metal. Kaocrete-D is widely used in this application.

How B&W refractory castables solve abrasion problems

Refractory castable linings used in metal-working furnaces are often subjected to severe mechanical abuse. Scraping by hand tools, loading and unloading, and the action of the molten metal and particle-laden gases all affect the life of refractories. Among B&W's line of refractory castables are two that are particularly suited to withstand unusual abrasive conditions. They are B&W Kaocrete-D and B&W Kaocrete-32, both of which have been used successfully in many demanding applications.

B&W Bulletin R-35A gives additional information on versatile B&W refractory castables. Write for copy to The Babcock & Wilcox Company, 161 East 42nd Street, New York 17, N.Y.

R606R

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